8-2006

Measuring the Safety Climate of Steel Mini-mill Workers using an Instrument Validated by Structural Equation Modeling

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Recommended Citation
Hall, Michael Edward, "Measuring the Safety Climate of Steel Mini-mill Workers using an Instrument Validated by Structural Equation Modeling. " PhD diss., University of Tennessee, 2006.
https://trace.tennessee.edu/utk_graddiss/1673

To the Graduate Council:

I am submitting herewith a dissertation written by Michael Edward Hall entitled "Measuring the Safety Climate of Steel Mini-mill Workers using an Instrument Validated by Structural Equation Modeling." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Human Ecology.

Susan Madison Smith, Major Professor

We have read this dissertation and recommend its acceptance:

Paula Carney, June Gorski, Tyler Kress, Greg Petty

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Anne Mayhew
Vice Chancellor and
Dean of Graduate Studies

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Measuring the Safety Climate of Steel Mini-mill Workers using an Instrument Validated by Structural Equation Modeling

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Michael Edward Hall
August 2006

Dedication

The following dissertation is dedicated to my father, William Edward Hall.

Acknowledgments

I would like to acknowledge my committee chairperson Dr. Susan Smith whose support and attention to detail allowed me to complete this project in a timely manner. I would also like to thank Dr. June Gorski for taking the time to accommodate my schedule for completion. A thank you goes out to my other committee members, Dr. Greg Petty, Dr. Tyler Kress, and Dr. Paula Carney for sticking with me through the evolution of this research project. I truly believe that end product eclipses the scope of the original proposal and that is directly related to the support and feedback I received from my committee members. I would like to thank my mother for reminding me everyday that finishing this degree was a priority. The unexpected loss of my father during my doctoral studies required that I change my schedule for completion of this dissertation. My family's consistent support allowed me to continue my research even under difficult circumstances. Finally, I want to thank my wife Kendra, I feel lucky to have someone that supports my dreams and encourages me to follow them.

Abstract

The research study entitled “Measuring the Safety Climate of Steel Mini-Mill Workers using an Instrument Validated by Structural Equation Modeling” created and field tested a new theory based safety climate instrument validated by structural equation modeling. The study also established an employee safety climate profile at three steel mini-mill locations in the United States. The safety culture of the employees and subcontractors at three locations was measured using the newly created Hall Safety Climate Instrument. The instrument was designed to measure safety climate of an organization where employees are required to practice a high level of safety skills and consistently high safety behavior because of the level of risk associated with certain work related operations. The Hall Safety Climate instrument measures safety climate and provides a “point in time” measure of safety culture.

The Hall Safety Climate Instrument was developed using the theoretical framework of the theory of planned behavior. The theory of planned behavior uses three constructs to explain why individuals choose to perform a particular behavior.

Reliability of the Hall Safety Climate instrument was established using Chronbach’s Alpha, exploratory factor analysis and confirmatory factor analysis. The validity of the instrument was demonstrated by structural equation modeling using AMOS.

Managers and Supervisors participating in the study self-reported a significantly higher safety climate than other participating employees. The individuals in the Maintenance departments of steel mini-mills self-reported a significantly higher safety climate than individuals in other mini-mill departments. Individuals self-reporting no previous work-related injuries achieved a higher safety climate score than those employees self-reporting previous work-related injuries. Despite having the same corporate mandated safety policies a significant difference in safety climate was found among the three corporate owned steel mini-mill locations in the United States participating in this study.

The Hall Safety Climate Instrument was designed, piloted and field tested to be used to assess the employee safety climate at facilities requiring a high safety reliability environment. An industry is considered to need high safety reliability when the high risk environment of workers could mean the use of an unsafe practice could result in very serious consequences for an employee including death or severe injury.

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CHAPTER I

FORMULATION AND DEFINITION OF THE PROBLEM

Introduction

In high-risk industries where employees work in areas with significant hazards the potential for serious injury exists (Barreto, Swerdlow, Schomker, & Smith, 2000; Brown, 1996; Brown, Willis, & Prussia, 2000; Clarke, 1999; Courtney & Webster, 2001; Dedobbeleer & Beland, 1991; Mearns, Whitaker, & Flin, 2001). Work-related injuries are costly in terms of money for compensation insurance; the morale of other employees; lost productivity; and potential loss of the affected employee.

In previous years the safety system approach to addressing accident reduction has been to examine “lagging” data, such as lost time accident rates, and incident rates (Flin, Mearns, O'Connor, & Bryden, 2000). The term lagging is used due to the retrospective nature of the databases used, i.e. the accident had to occur before it could be entered into the database.

The current focus of the safety system approach is on accident prevention using predictive measures as a way of method of safety condition monitoring (Flin et al., 2000). The use of predictive measures to monitor safety conditions moves away from the idea that in order for the safety system to be improved, failures in the system have to occur.

Traditional methods of improving the safety system focused on accident investigations to find a root cause that was technical in nature (Petersen, 1996). However, current research suggests that human behavior may have a stronger role in accidents than was first suspected (Brown, 1996; Brown et al., 2000; Carder & Ragan, 2003; Cooper, 2002; DePasquale & Geller, 1999; Flin et al., 2000; Griffin & Neal, 2000; Hayes, Perander, Smecko, & Trask, 1998; O'Toole, 2002). The redirection of accident prevention from technical causes to behavior factors is driven by research focusing on organizational culture, human factors, and safety culture.

Safety culture and safety climate have been studied by many researchers in a variety of industrial settings (Clarke, 1999; Cooper, 2002; Dedobbeleer & Beland, 1991; Diaz & Cabrea, 1997). However, there has been a lack of consensus as to the definition of the terms "safety culture" and "safety climate" (Zhang, Wiegmann, von Thaden, Sharma, & Mitchell, 2002). Zhang et al. (2002) conducted a meta-analysis of 107 documents that referenced "safety culture/climate measurements". The study found that there existed a considerable disagreement between authors as to how safety culture/climate should be defined (Zhang et al., 2002). Based on Zhang et al. (2002) and the researcher's own findings via literature review, operational definitions of safety culture/safety climate for the purposes of this study were formed.

Safety culture is an emerging area of focus among researchers studying the root causes of injuries (Arboleda, Morrow, Crum, & Shelly II, 2003; Brown et al., 2000; Carder & Ragan, 2003; Clarke, 1999; Cooper, 2002; Petersen, 1996). The basis of safety culture is the beliefs and attitudes toward safety within an organization (Zohar, 1980). Clarke (1999) defined safety culture as "a subset of organizational culture, where the beliefs and values refer specifically to matters of health and safety." Additionally, safety culture is a collection of characteristics and attitudes in organizations and individuals that establishes a priority of safety issues receiving attention based on significance (Mearns et al., 2001). An operational definition for purposes of this study is that safety culture is a manifestation of a concept developed at group level or higher, which refers to the shared attitudes and behaviors among all organization members. Safety culture is also relatively enduring and stable. This concept of culture at an organizational level is idiographic requiring a qualitative measurement (Shadur, Kienzle, & Rodwell, 1999). Culture is embedded in the group or organization and is difficult to measure; however, climate is an acceptable surface indicator of culture (Shadur et al., 1999).

Safety climate contributes to the organization's underlying safety culture through employee safety behaviors and expressed attitudes (Mearns et al., 2001). Furthermore, safety climate can be thought of as the measure of safety culture derived from the attitudes and behavior of the organization's members at a point in time (Dedobbeleer & Beland, 1991; Flin et al., 2000). Safety culture can be indirectly measured from instruments that measure safety climate (Flin et al., 2000). An operational definition of safety climate is that it includes the collective attitudes and behaviors associated with the state of safety at a particular moment. Safety climate is relatively unstable, and subject to change depending on current conditions and is considered a temporal state of measure of safety culture.

Measurement of safety climate requires an instrument to record perceptions on safety issues from the person taking the survey. Safety climate is the resulting score from a summation of safety attitude and behavior measurement items within a survey. Organizational factors as related to productivity have been measured by perception surveys administered by Dr. Rensis Likert (Petersen, 1996). Likert's research examined the establishment of a relationship between "high achievement" and scoring high on the perception instrument domains. These domains or themes included: support, supervision, attitude toward the company, and motivation. The high correlation also supports the usefulness of the surveys to indicate weak areas that can be addressed by managers. In theory, improving the deficient areas of the survey results will improve productivity of the workers (Petersen, 1996).

This same concept was adapted to safety management by Dr. Dan Petersen during the development of the “Minnesota Perception Survey” which analyzed safety perceptions in the railroad industry (Bailey & Petersen, 1989). Dr. Petersen found that the effectiveness of safety programs cannot be measured by traditional procedural-engineering criteria. Safety program effectiveness is best measured by responses from the entire organization to questions about the safety system that have an effect on human behaviors; and, that the most successful safety programs are those which recognize worker and supervisor behavior and attitude which affect safety (Bailey & Petersen, 1989). Bailey and Petersen (1989) concluded that safety climate surveys were a better measure of safety performance and predictor of safety results than traditional audit programs.

Therefore, this research chooses to explore the development of a safety climate measure to be used as a tool to prevent work-related injuries. The setting selected for study is a high-risk environment and the potential for serious injury exists.

Statement of the Problem

The review of currently available safety climate instruments indicates a deficit of reliable and valid surveys that use a theoretical framework. In order to prevent work-related injuries a valid and reliable safety climate instrument is necessary to measure the individual’s perceptions of safety.

Purpose of the Study

The purpose of the research study was to 1) develop a reliable theory based safety climate survey instrument validated by structural equation modeling to assess the safety climate of steel mini-mill employees and on-site contractors at three mill company locations within the United States and 2) establish an initial profile of the safety climate at three steel mini-mill company locations with in the United States,

Research Objectives

1. Develop a reliable theory based safety climate survey instrument validated by structural equation modeling to assess the employees' and on-site contractors perceptions of safety themes contributing to the overall safety climate of three steel mini-mill company within the United States.
2. Determine the safety climate of steel mini-mill employees and on-site contractors at three mill locations within the United States, using a reliable safety climate survey instrument validated by structural equation modeling.

Research Questions

1. How does safety climate differ among job positions of "Manager", "Supervisor", "Employee", and "Non-Exempt" working at three steel mini-mills in the United States?

2. How does safety climate differ among departments for “Melt Shop”, “Rolling Mill”, “Maintenance”, “Administration”, and “Contractor” working in three steel mini-mills in the United States?

3. How does safety climate differ between employees and on-site contractors that self-reported a previous work-related injury and those that reported no previous work-related injury at three steel mini-mills in the United States?

4. How does safety climate differ between employees and on-site contractors that self-reported an awareness of a hazard in their immediate work area and those that reported no awareness of a hazard in their immediate work area at three steel mini-mills in the United States?

5. How does safety climate differ among geographic work locations for employees and on-site contractors working in three steel mini-mills in the United States?

Rationale and Need for the Study

A safety climate assessment can be used to benchmark a safety program and/or to evaluate progress of a safety program (Arboleda et al., 2003; Bailey & Petersen, 1989; Blair, 2003; Brown et al., 2000; Carder & Ragan, 2003; Clarke, 1999; Cooper, 2002; Diaz & Cabrea, 1997; Geller, 2000; Griffin & Neal, 2000; Mearns et al., 2001; Petersen, 1996; Zohar, 1980). Safety climate is a collection of attitudes and behaviors as expressed at a point in time. The complexity of human behaviors requires an approach that is systematic in order to understand the origins of those behaviors (Ajzen, 1991). Behavior theory is a tool for researchers that provides guidance for measurement and assessment of the impact of interventions designed to influence behavior choices (Glanz, Lewis, & Rimer, 1997). The use of theories during the various stages of planning and evaluation allows the researcher to shape the pursuit of answers to why, what, and how (Glanz et al., 1997). The development of a scale to measure safety climate that is based on human behavior theory affords the researcher with an instrument that measures the constructs of that theory.

Of the 4.4 million work-related injuries reported in 2002, the manufacturing sector, which includes the steel industry accounted for 23%, which was the third highest sector (Statistics, 2004). The injury rate for the steel industry increased from 15.2 in 2003 to 17.0 in 2004 (Statistics, 2004). Manufacturing had 26.3% of the injury cases in which work days were lost or required a job reassignment (Statistics, 2004). The high number of injuries as reported by BLS, the growing workforce, and the increasing demand for construction materials including steel products indicates a great need for interventions designed to improve safety programs in order to prevent work-related injuries in the steel manufacturing setting. Safety climate measurement has been shown to illustrate the industrial accident process through the linking of safety climate scores and risk behaviors (Hayes et al., 1998). The researchers noted that safety climate was linked to accident-related variables (Hayes et al., 1998). Therefore, accidents could be prevented if countermeasures were taken to address areas of safety climate that pointed to specific accident-related variables that needed attention. Uncovering accident-related variables enables safety managers to shift program focus and to address those variables.

Flin et al.(2000) found that a proliferation of safety climate instruments lacked a unifying theoretical model, and few attempted validity and reliability measures. Most instruments were customized to fit the sponsoring organization's requirements. Many used focus groups and interviews to determine specific safety issues for that particular workforce and tailored the instrument to address those issues. A few instruments have attempted to determine an underlying factor structure (Brown, 1996; Brown et al., 2000; Brown & Holmes, 1986; Mearns et al., 2001; Niskanen, 1994). However, Flin found that methodological inconsistencies as well as cultural differences creates a difficult task of bridging the factor structures into a common group (Flin et al., 2000).

Assumptions, Limitations and Delimitations of the Study

Assumptions

The basic assumptions made regarding the study were:

1. Subjects that completed the survey instrument did so of their own free will.

2. Subjects that completed the survey instrument answered the questions honestly and accurately.

Limitations

The research study included the following limitations:

1. The study was limited to self-reported data with no observational follow up to verify conditions were as reported.
2. The study was limited to steel mini-mill employees and on-site contractors that attended the safety meetings and voluntarily chose to complete the anonymous survey.

Delimitations

The research study included the following delimitations:

1. This study was delimited to employees and on-site contractors of one steel mini mill corporation at three geographic locations in the United States.

2. Generalization of the results are delimited to the sample of convenience of employees participating from three steel mini-mill locations in the United States.

Definition of Terms

Definitions

Employee – operationally defined for purposes of this study as hourly wage-worker that performs duties directly for the steel mini-mill

Location – operationally defined for purposes of this study as the geographic site where the mill operations take place

Hazard awareness – operationally defined for purposes of this study as any safety issue in the immediate work area that causes concern to the employee while performing duties related to a job

Non-exempt – operationally defined for purposes of this study as salaried employees that are eligible for overtime wages beyond their normal work hours. These employees are not at a supervisory or management level

Previous work-related injury – operationally defined for purposes of this study as any prior incident that resulted in an injury while performing duties related to a job

On-site Contractor – operationally defined for purposes of this study as an individual performing duties at a location that is not an employee of the corporation

Manager – operationally defined for purposes of this study as an executive level employee of the corporation that oversees a department

Supervisor – operationally defined for purposes of this study as a line level employee of the corporation that directly oversees the employees of a department

Safety Climate – operationally defined for purposes of this study as the collective attitudes and behaviors associated with the state of safety at a particular moment. (Zohar, 1980)

Safety Culture – operationally defined for purposes of this study as a manifestation of a concept developed at group level or higher, which refers to the shared attitudes and behaviors among all organization members. (Turner, 1994)

Steel Mini-Mill – operationally defined for purposes of this study as a secondary steel producer that obtains most of its iron from scrap steel, recycled from used automobiles and equipment or byproducts of manufacturing

Work-related – operationally defined for purposes of this study as pertaining to an action taking place during the course of performing work, or during the hours of work.

Summary

In summary, this chapter presented an introduction, statement of the problem, research objectives, research questions, the rationale and need for the study, assumptions, delimitations, limitations and definition of terms.

Chapter II will discuss literature reviews covering areas in similar content, methodology and content, and methodology that specifically relate causal factors with work related injuries. Chapter III will describe methodologies in data collection and analysis that were used to address the research questions. Chapter IV describes the data and data analysis. Chapter V focuses on the findings and conclusions drawn from this study as well as recommendations for future research. Finally, Chapter VI will reflect upon the research study in retrospect.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The purpose of the research study was to 1) to establish an initial profile of perceptions that contribute to safety climate at three locations of a steel mini-mill employer located in the United States, and 2) develop a valid and reliable safety climate survey instrument to assess the safety climate of a steel mini-mill employer in the United States. A review of literature was conducted to determine the relationship of employee perceptions of safety and the organization's safety culture, and how management's perceived support of safety programs affects safety culture. Information on current employee perception instruments are presented in this chapter, with discussion of specific domains of interest regarding measurement of safety attitudes.

Sections are also included in this chapter to relate the establishment by literature of the methodology, including similar studies conducted to assess how employee safety perceptions may affect safety culture. The final section of this chapter will discuss the methodology related specifically to the content and the population under study and development of survey instruments to measure perceptions.

Conceptual Basis: Theory of Planned Behavior

A theoretical framework for the study was used to establish the research direction. The Theory of Planned Behavior (TPB) was selected as the framework to explore the relationship between attitudes, beliefs, and self-efficacy that may affect decisions of the individual to follow prescribed safety protocols (Montano, Kasprzyk, & Taplin, 1997). The theory of planned behavior is an extension of the theory of reasoned action. The central factor in the theory of planned behavior is the individual's intention to perform a behavior. Constructs of the theory of planned behavior shown to affect health decisions are: (a) attitudes, (b) subjective norms, and (c) perceived behavioral control (Montano et al., 1997).

Attitudes

Behavioral beliefs associate the behavior with expected outcomes. The behavioral belief is the probability, according to the individual, that a behavior will generate a positive or negative outcome. The individual's subjective value of the expected outcome leads to formation of an attitude toward the behavior. The strength of the attitude is determined by the behavioral belief, which is weighted by the evaluation of the outcome:

Attitude (A) = $\Sigma b_i e_i$

Subjective Norms

Subjective norms pertain to the perceived social pressures to perform or not perform the behavior. As such, social pressures are derived from important referent individuals or group's approval or disapproval of performing a behavior. The strength of each normative belief (n) is multiplied by the person's motivation to comply (m) with the social pressure in question, and the subjective norm (SN) is directly proportional to the sum of the resulting products:

$SN = \Sigma_{i=1} n_i m_i$

A measure of SN is obtained by asking respondents to rate the extent to which "important others" would approve or disapprove of their performing a given behavior. Typically, the best measures of subjective norms are obtained with bipolar scoring of normative beliefs and uni-polar scoring of motivation to comply (Ajzen & Fishbein, 1980).

Perceived Behavioral Control

Perceived behavioral control refers to the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated barriers. This set of beliefs is related to the presence or absence of resources and opportunities in relation to performing a behavior. The control beliefs may have origin in past experiences with the behavior, but more likely to be influenced by information learned from others. Thus, the more resources or opportunities individuals believe they possess, and the fewer barriers they anticipate, the great their perceived control over the behavior (Ajzen & Fishbein, 1980). Each control belief (c) is multiplied by the perceived power (p) of the control factor to facilitate or inhibit performance of the behavior. The products are summed to produce the perception of behavioral control (PBC):

$PBC = \Sigma_{i=1} c_i p_i$

As a general rule, the more favorable the attitude and subjective norms toward a behavior, and the greater the perceived behavior control, the stronger the individual's intention to perform the behavior (Ajzen & Fishbein, 1980). The theory constructs are graphically represented in Figure 2.1 The Theory of Planned Behavior.

Research Related to Safety Climate

Injuries in High Risk Occupations

An estimated 4500 work-related injuries resulting in death in the United States for 2003 (*Report on Injuries in America, 2003*, 2006). In 2004 this number increased to 5764 work-related injuries resulting in death (Statistics, 2006). The cost associated with the 2003 death statistic was 27.1 million dollars per death (*Report on Injuries in America, 2003*, 2006). As a whole, work-related accidents that result in death cost Americans 156.2 billion dollars in 2003 (*Report on Injuries in America, 2003*, 2006). The National Safety Council has recommended that American companies' increase their safety education efforts to meet the needs of the workers (*Report on Injuries in America, 2003*, 2006). The increasing costs, monetary and human, that are associated with work-related unintentional deaths, creates a need to develop safety management programs to measure safety climate (Hayes et al., 1998; Zohar, 1980).

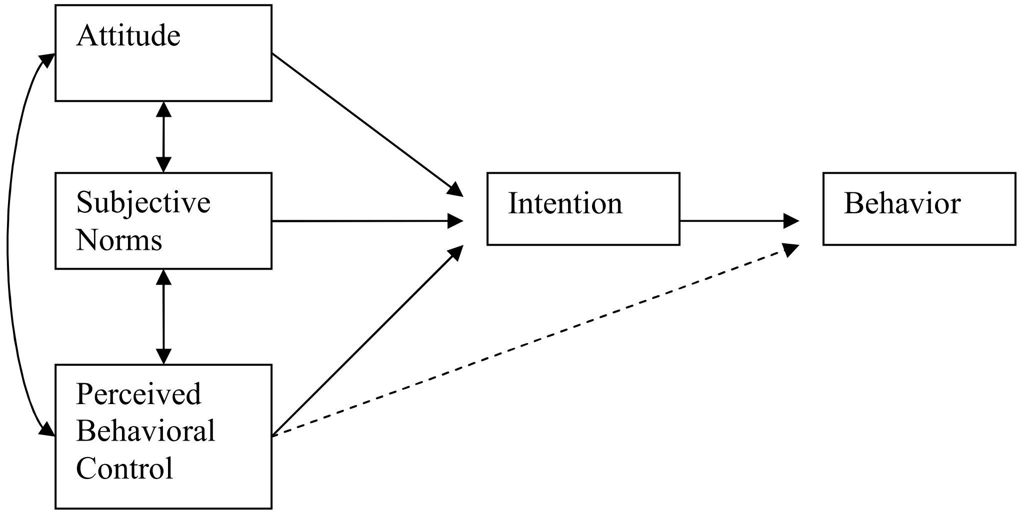

Figure 2.1 The Theory of Planned Behavior

Occupational Safety Management

The psychology of safety management shared by many safety professional is that injuries involve both people and the environment, not solely conditions or things, the Psychology of Safety Management era (Sarkus, 2001). Workplace safety has evolved from an ancillary issue to an operating priority with significant implications for operations managers (Brown et al., 2000). In 1970 the Occupational Safety and Health Act was passed and created the Occupational Safety and Health Administration (OSHA). OSHA is the federal agency responsible for development and enforcement of regulations governing worker health and safety. Citations, monetary penalties, and even criminal charges may be issued to managers for failing to follow guidelines set forth by OSHA. Standards and regulations on safety of workers places a compelling need for safety managers to determine factors that lead to work-related injuries. A more complete understanding of workplace safety may be gained by comparing the perceptions of management and workers (Brown et al., 2000). The concept of safety perception lies in the study of behavioral safety. If an employee perceives a safety program to be ineffective, or not a concern of supervisors and managers, employees are less likely to follow procedures outlined by the program (Hagan, Montgomery, & O'Reilly, 2001). A person’s behavior is determined by favorable or unfavorable outcomes, which in turn, determines future behavior (Hagan et al., 2001). Safety leaders and management must consider the employee’s perception of the safety program. When the behavioral aspect of a safety program is not addressed, the personal responsibility of the individual to act safely is neglected (Hagan et al., 2001). When safety rules are ignored, then incidents may occur due to risky behaviors (Griffin & Neal, 2000; Hagan et al., 2001) . If an injury results, the employee may feel that it was an accident that was unrelated to risk taking behaviors (Griffin & Neal, 2000).

Many industrial production companies have safety programs in place to address work-related injuries (Bailey & Petersen, 1989; Brown et al., 2000; Cooper, 2002; Zohar, 1980). Safety procedures outline operation of equipment and methods of performing work-related tasks. Work-related accidents happen in facilities that have safety procedures. The reason for these accidents may require an understanding of employee behavior-based safety (BBS). Behavior based safety involves the psychosocial aspect of employee decision making, in regards to safety (Geller, 2000).

Behavior Based Safety: Safety Culture/Safety Climate

Behavior based safety applied to employee psychology can be viewed as Safety Culture and Safety Climate (Geller, 2000). Safety Culture can be thought of as being more global than Climate, and would include employee assumptions, values, norms and beliefs. Safety Climate would be a reflection of Culture gathered through surveys or questionnaires. Safety Climate is a “snap shot” of Safety Culture at a point in time. The safety professional uses Safety Climate to assess the present Safety Culture and to measure employee attitudes during implementation of safety programs.

Safety Culture

Safety culture is a concept derived from corporate culture (Blair, 2003). Corporate culture is a blend of behaviors, attitudes and performance outcomes that move the organization(Blair, 2003). The culture reflects shared behaviors, attitudes and values regarding goals (Cooper, 2002). However, organizational culture is heterogeneous and varies from division to division (Arboleda et al., 2003). When safety is understood and recognized as the organization's top priority, then it can be said that a safety culture exists (Blair, 2003; Cooper, 2002; DePasquale & Geller, 1999). Turner, (1994) defines safety culture as, "the set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimizing the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious." A positive safety culture, as expressed at all levels of hierarchy within the organization, is reflective of the relationship of employee perception of safety and management's commitment to safety (O'Toole, 2002).

The goal for managers is to allocate resources in a manner that leads to a productive end. Resources in this case include: time, money, and personnel. One responsibility of managers is the safety and health of their employees. Managers are tasked with allocating the least amount of resources that yield the lowest possible number and severity of injuries. With limited resources to help reduce occupational injuries, companies must be efficient in the use of these resources to achieve the greatest reduction in injuries. The concept of safety culture is used as the basis of understanding the importance of safety within an organization. Ideally, a homogeneous perception of safety would allow for determination of the safety culture. However, there are differences in perceptions along the hierarchical lines of supervision (Bailey & Petersen, 1989; Blair, 2003; Brown et al., 2000; Carder & Ragan, 2003; DePasquale & Geller, 1999; Flin et al., 2000; Williamson, Feyer, Cairns, & Biancotti, 1997). In order to identify the different perceptions, safety personnel may utilize safety perception surveys.

Safety Climate

Safety climates over time collectively make up the organization's safety culture (Zohar, 1980). Safety climate studies observe the collection of attitudes and perceptions of employee regarding the safety of the organization (Niskanen, 1994; Williamson et al., 1997; Zohar, 1980). Safety climate studies provide an assessment of the safety culture for a particular point in time (Zohar, 1980). Safety climate studies can provide information of organizational safety as it is perceived by the members of the organization. This information can be used to improve the existing safety management system to address findings from safety climate studies.

Summary

The high cost of work-related accidents forces organizations to developed programs to protect its workers from accidents. The safety management system has evolved over time to meet the needs of the workforce. The shift from engineering controls to human behavior based safety has been advocated by many as being key to the development of a higher level of safety management (Cooper, 2002; Geller, 2000; Kamp, 2001). The concepts of safety culture and safety climate are important to researchers because they conceptualize the underlying factors that drive the decisions to choose safe behaviors in the workplace.

Research Related to Safety Climate Measurement

How Safety Climate is Measured

The basic construct of behavior based safety consists of: identifying behaviors that impact safety; defining these behaviors so that they may be measured reliably; development of system to measure these behaviors in order to produce a “safety climate”; be able to provide feedback to employee on the behavior status; and to encourage progress (Sulzer-Azaroff & Austin, 2000). One way of measuring behaviors and attitudes is through the use of safety climate instruments. A number of instruments exist for the purpose of measuring safety climate (Brown et al., 2000; Budworth, 1997; Carder & Ragan, 2003; Clarke, 1999; Cox & Cox, 1991; Dedobbeleer & Beland, 1991; Hayes et al., 1998; Mearns et al., 2001; Niskanen, 1994; Williamson et al., 1997). The instruments are a collection of response items that intend to measure an attitude regarding an aspect of organizational safety (Flin et al., 2000).

Safety Climate Instrument Discussion

Behavioral based safety seeks to determine the underlying forces that drive the individual to choose unsafe risk behaviors (Geller, 2000, 2002; Kamp, 2001). Despite the proliferation of human behavior theories in existence, there has been a lack of behavior theory basis in safety climate instrument development (Brown et al., 2000; Carder & Ragan, 2003; Clarke, 1999; Dedobbeleer & Beland, 1991; Hayes et al., 1998; Niskanen, 1994; Williamson et al., 1997; Zohar, 1980). Instruments were developed using anecdotal measures to determine response item selection such as, roundtable discussions, interviewing the sample population, or using sections from existing surveys (Clarke, 1999; Hayes et al., 1998; Niskanen, 1994). Few researchers have attempted or reported validity measures of their instruments (Brown & Holmes, 1986; Mearns et al., 2001; Williamson et al., 1997). Many published studies of the development of safety climate instruments did not report measures of reliability or validity measures (Budworth, 1997; Carrol, 1998; Cox & Cox, 1991; Dedobbeleer & Beland, 1991).

Summary

Safety climate instruments are designed to measure the responses to items relating to attitudes about safety. These instruments exist in many forms and are used in many industries (Brown et al., 2000; Budworth, 1997; Carder & Ragan, 2003; Clarke, 1999; Cox & Cox, 1991; Dedobbeleer & Beland, 1991; Hayes et al., 1998; Mearns et al., 2001; Niskanen, 1994; Williamson et al., 1997). However, the lack of theory basis, lack of consistent development protocol, and lack of consistent validity and reliability measures indicate a need for research into development of an instrument that meets those voids.

Research Related to Safety Perception Instrument Development

Structural Equation Modeling

The use of structural equation modeling has been increasing in the organizational and safety climate research areas (Hofman & Morgenson, 1999; Neal, Griffin, & Hart, 2000; Oliver, Cheyne, Tomas, & Cox, 2002). Structural equation models allow researchers to test and modify hypothetical and theoretical models of theory (Anderson & Gerbing, 1988). These models can be separated into two processes: structural model building and measurement model building (Anderson & Gerbing, 1988). Structural models can be tested using factor analysis. The factor analysis can be done in exploratory mode and a confirmatory mode (Anderson & Gerbing, 1988). In the exploratory mode no specification is made about the underlying factor structure of the instrument. Instead, the analysis using a maximum likelihood (ML) or generalized least squares (GLS) is used to generate a table of item-factor loadings and the researcher determined the underlying factor structure (Anderson & Gerbing, 1988). The confirmatory factor analysis component is used to test the known priori as found in the exploratory factor analysis component (Anderson & Gerbing, 1988). This known priori places a restriction on the model for testing purposes. In this environment theoretical considerations can be used to test hypothetical priori in the software environment (Byrne, 2001). Another component of structural equation modeling involves the use of pathway models (MacCallum & Austin, 2000). Pathway models are a graphical representation of the theory structure and in the case of safety climate studies, the underlying components of the instrument (Oliver et al., 2002).

Internal Consistency Reliability of Safety Themes

Internal consistency reliability tests the variable(s) generated from the responses to a set of items in an instrument. One measure of internal consistency reliability is Cronbach's alpha (Schmitt, 1996). Cronbach's alpha is an index of reliability associated with the variation accounted for by the score of the factor structure (Schmitt, 1996). Several safety climate studies have used Cronbach's alpha as a method of establishing a reliability measure for the instrument design (Carder & Ragan, 2003; Clarke, 1999; Hayes et al., 1998; Williamson et al., 1997). These previous studies used Cronbach's alpha values to determine the reliability of the multidimensionality of the instrument. One area of difference found in the studies of safety climate instrument internal consistency reliability assessment is the Cronbach's alpha value to use as an indicator of group reliability (Carder & Ragan, 2003; Clarke, 1999; Hayes et al., 1998; Williamson et al., 1997). Schmitt (1996) cautions that the use of an alpha value (usually .7) as a measure of adequacy is too often done so without other considerations. Schmitt (1996)addresses the support of alpha levels below .7 may be acceptable when scale length is an issue. For example if a group of items has an alpha value of .6, it may be acceptable because the group is comprised of three items, therefore it would be expected to have a lower Cronbach's alpha value (Schmitt, 1996).

Summary

In the next chapter, Chapter III, specific methodology will be discussed along with instrumentation chosen for this study. Chapter IV will follow with an in-depth analysis of data collected. Then Chapter V will follow with results and conclusions specifically drawn from this study. Chapter VI will follow in retrospect of the study.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this chapter was to describe the methods and procedures used in the study to address instrument development, the study population, administration of the instrument field test, the statistical design of the study and analysis of the data collected. Additionally, the chapter includes sections that measure group differences in safety climate among workers in the steel mini mill facilities.

Research Objectives

1. Develop a valid and reliable safety climate survey instrument, which is based on the theory of planned behavior, to assess the employees' and on-site contractors perceptions of safety themes that contribute to the overall safety climate of a steel mini-mill corporation located in the United States.
2. Determine the safety climate of steel mini-mill of employees and on-site contractors at three mill locations within the United States, using a valid and reliable safety climate survey instrument.

Research Questions

1. How does safety climate differ among job positions of “Manager”, “Supervisor”, “Employee”, and “Non-Exempt” working at three steel mini-mills in the United States?

2. How does safety climate differ among departments for “Melt Shop”, “Rolling Mill”, “Maintenance”, “Administration”, and “Contractor” working in three steel mini-mills in the United States?

3. How does safety climate differ between employees and on-site contractors that self-reported a previous work-related injury and those that reported no previous work-related injury at three steel mini-mills in the United States?

4. How does safety climate differ between employees and on-site contractors that self-reported an awareness of a hazard in their immediate work area and those that reported no awareness of a hazard in their immediate work area at three steel mini-mills in the United States?

5. How does safety climate differ among geographic work locations for employees and on-site contractors working in three steel mini-mills in the United States?

Instrumentation

No safety climate instrument was found through a review of the literature as being available with reported reliability, validity procedures and with documentation indicating that the instrument had been developed using a framework based on the health related "theory of human behavior." Most safety climate instruments documented in the literature were reported to be developed for use in a specific project or population and were not suitable or not available for the sample employee populations selected for the study. (Bailey & Petersen, 1989; Brown et al., 2000; Carder & Ragan, 2003; Clarke, 1999; Dedobbeleer & Beland, 1991; Diaz & Cabrea, 1997; Flin et al., 2000; Griffin & Neal, 2000; Niskanen, 1994; O'Toole, 2002; Petersen, 1996; Williamson et al., 1997).

This study attempted to develop a reliable safety climate instrument validated by structural equation modeling. The development of the safety climate instrument was guided by the conceptual framework of the Theory of Planned Behavior.

Hall Safety Climate Instrument Development

The Hall Safety Climate Instrument development was initiated by assigning seven safety themes: "Manager/Supervisor attitude toward safety"; "Risk"; "Group Norms"; "Workplace Pressure"; "Competence"; "Safety System"; and "Intention to follow safety procedures" to one of three constructs of the theory of planned behavior: "Attitude toward behavior"; "Subjective Norms"; and "Perceived behavioral control". The six safety themes assigned were identified by a review of published research discussing outcomes of safety climate studies and/or instrument construction. This review of published research included gathering information on 18 safety climate instruments. The six themes chosen by the research for use in the Hall Safety Climate Instrument were reported in the literature as being the most salient measures of safety climate (Flin et al., 2000). In addition to the six themes initially selected for use: (1) Management/Supervision attitude toward safety, (2) Safety System, (3) Risk, (4) Work Pressure, (5) Competence, (6) Group Pressure. The researcher added a seventh theme of Intention to follow safety procedures, as an outcome variable. The seventh safety theme was added by the researcher to account for the "intention" variable needed to fulfill the Hall Pathway Model derived from the theory of planned behavior. Fogarty and Shaw (2004) found that an intention variable was needed to fulfill the requirements of the theory of planned behavior when used to model safety climate. The theory of planned behavior constructs, Fogarty and Shaw's model and the Hall Pathway Model are presented in Table 3.1 Theory Construct Assignment of Fogarty and Shaw Model and Hall Safety Theme Model.

The content validity of the six safety themes was strengthened because all 18 safety climate instruments analyzed by Flin (2000) had items that measured all six of the safety themes. The seven safety themes were general in nature and were intended to address issues of common importance to workers in many industrial groups and were not specific to any industry. The selection of themes was intended to support the development of an instrument that could be utilized in broader industrial sectors that the steel mini-mill operations selected as specific sample populations.

Table 3.1 Theory Construct Assignment of Fogarty and Shaw Model and Hall Safety Theme Model*

Categories Assigned for Analysis	**Theory of Planned Behavior**	**Fogarty and Shaw Model**	**Hall Safety Theme Model**
Factor Linking Determinants[1]		"Management Attitude to Safety"	"Management/ Supervisor Attitude to Safety"
Determinant of Intention #1	"Attitude"	"Own Attitudes to Violations"	"Risk"
Determinant of Intention #2	"Subjective Norms"	"Group Norms"	"Group Norms"[2]
Determinant of Intention #3	"Perceived Behavioral Control"	"Workplace Pressures"	"Workplace Pressures" "Competence"[3] "Safety System"[3]
Measurement Variable #1	"Intention"	"Intention to Violate"	"Intention to Follow Safety Procedures"
Outcome	"Behavior"	"Violation"	See Footnote[4]

* The table is read by selecting a component from the component column and reading left to right to view how the component is addressed for TPB, Fogarty and Shaw's Model, and Hall Safety Theme Model.

1. Use of factor link was identified by findings of Fogarty and Shaw (2004) as an external link affecting "Determinants of Intention"
2. "Group Norms" added by author and used in "Hall Safety Theme" model as recommended by Fogarty and Shaw (2004) as a measure of "Subjective Norm"
3. "Competence" and "Safety System" added by author to increase strength of "Workplace Pressures" which was found by Fogarty and Shaw (2004) to be an inadequate substitute for "Perceived Behavioral Control"
4. Author chose to measure "Intention to Follow Safety Procedures" as an indirect measure of behavior as recommended by Ajzen (1991) based on findings that intention is highly correlated with actual performance of behavior

A panel of three experts was created to assist the researcher in establishing the face validity of the safety theme to construct assignment. Two members of the panel were university professors with experience in psychometric design; the third member was a PhD safety manager with experience in administering and interpreting results of safety climate instruments. The theoretical basis used for the construction of the Hall Safety Climate Instrument was confirmed by the expert panel. The safety theme(s) assigned by the researcher to represent each of the theory constructs was reviewed by the expert panel. The panel was requested to determine if the researcher appropriately represented the theory construct with the selected safety theme(s).

The items incorporated under each theme/factor section by the researcher were generated through the review of current literature and the review of available instruments. The items, adapted for use in the Hall Safety Climate Instrument, were consistent in context to those used in safety climate surveys determined by a rigorous review of the literature. Individual items were included to gather demographic information to characterize if the individual respondent had: experienced an injury event, acknowledged hazards in the work area, currently worked in a specific job position and/or worked in a specific department.

When the instrument was piloted the Hall Safety Climate Instrument included 65 items to measure worker perception of safety climate. Each of the 65 items was initially assigned to reflect an issue under one of the seven safety themes. After all items were confirmed to reflect needed information related to a specific theme, the 65 items were randomly placed on the questionnaire regardless of the theme each item represented. .

The questionnaire form was designed to allow respondents to record their level of agreement with each of the 65 items based on a five-point Likert scale. A response scale was adapted from previous safety climate instruments discussed in the literature, including: an unnamed instrument by Clarke; the Work Safety Scale; and an unnamed instrument by Williamson et al.; (Clarke, 1999; Hayes et al., 1998; Poss, 1999; Williamson et al., 1997). The response options available to the respondent included: *1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree.* The Hall Safety Climate Instrument score was designed to be calculated by reverse scoring the appropriate items and averaging the 65 response item resulting in a numerical score. The safety themes initially proposed in this research were utilized for instrument design purposes and the issues by individual themes will be further refined as the instrument development incorporates factor analysis procedures.

Design of Variables for Coding

Responses to survey questions were on the Likert type scale were coded for data analysis with a '5' for 'Strongly Agree', a '4' for 'Agree', a '3' for 'Neutral', a '2' for 'Disagree', and a '1' for 'Strongly Disagree'. Responses to item 1 "Department" were coded for data analysis with a '1' for 'Melt Shop', a '2' for 'Rolling Mill', a '3' for 'Maintenance', a '4' for 'Administration', and a '5' for 'Contractor'. 'Contractor' was used to measure responses from on-site contractors that worked at the steel mini-mill location. Respondents that self-reported 'Contractor' were instructed to use job position '3' for 'Employee' since that classification best fit these particular workers. Responses to item 2 “Level” were coded for data analysis with a ‘1’ for ‘Manager’, ‘2’ for ‘Supervisor’, ‘3’ for ‘Employee’, and ‘4’ for ‘Non-Exempt’. ‘Non-Exempt’ is a job classification that is distinct from ‘Employee’ because these are salaried workers that unlike managers and supervisors can receive overtime compensation beyond a 48-hour work week. Responses to item 3 “Are there any hazards in your direct work area?” were coded for data analysis with a ‘1’ for ‘Yes’ and a ‘0’ for ‘No’. Responses to item 4 “At this or any previous place of employment have you ever been involved in a work-related accident that resulted in an injury?” with a ‘1’ for ‘Yes’ and a ‘0’ for ‘No”.

Development of the Hall Pathway Model: Application of the Theory of Planned Behavior

Theory of Planned Behavior

The theory of planned behavior postulates that human action is guided by three kinds of considerations: Attitude toward behavior, subjective norm, and perceived behavioral control (Ajzen & Fishbein, 1980). To evaluate safety behavior using the theory of planned behavior a method of measuring each of the three constructs was required. The researcher chose to assign the seven safety themes selected for consideration as a part of the proposed Hall safety climate instrument to each of the three theory constructs: “Attitude toward behavior”; “Subjective Norms”; and “Perceived behavioral control”. The seventh safety theme was added by the researcher to account for the “intention” variable needed to fulfill the Hall Pathway Model derived from the theory of planned behavior. The theory of planned behavior constructs and operational definitions are provided in Table 3.2 Operational Definitions of Theory of Planned

Table 3.2 Operational Definitions of Theory of Planned Behavior Constructs

Construct	Definition
Attitude Toward Behavior	The value expectancy the individual has for the behavior. Favorable behaviors have desirable consequences, and unfavorable attitudes towards behaviors have undesirable consequences.
Subjective Norm	Normative beliefs are concerned with the likelihood that important referent individuals or groups (i.e. significant others) approve or disapprove of performing a given behavior. Additionally, the individual’s motivation to comply with the referent is considered to develop an overall global measure.
Perceived Behavioral Control	The more resources and opportunities individuals believe they possess, and the fewer obstacles or impediments they anticipate, the greater their perceived control over the behavior. Resources and opportunities can be extended to include the concept of self-efficacy.

Behavior Constructs, and will be used throughout the continued development of the Hall Pathway Model and the Hall Safety Climate Instrument.

The safety themes and operational definitions are provided in Table 3.3 Operational Definitions of Safety Themes, and will be used throughout the continued development of the Hall Pathway Model and the Hall Safety Climate Instrument.

A panel of three experts included two university professors with experience in psychometric design, and a PhD safety manager with experience in safety climate research reviewed the initial draft of the proposed Hall Pathway Model. The expert panel confirmed the researcher's recommended the Hall Pathway Model and its incorporation of the previously documented seven safety themes to represent the four constructs of the theory of planned behavior within the model. The Hall Pathway Model hypothesized that the constructs of the theory of planned behavior can be indirectly assessed by measuring the following safety themes: "Manager/Supervisor support of safety program"; "Safety System"; "Risk"; "Workplace Pressure"; "Competence"; "Group Norms"; and "Intention to follow safety procedures". Each safety theme is represented within the pilot Hall Safety Climate Instrument by a series of individual response items. Safety themes with the associated group of response items are presented in Table 3.4 Safety Theme and Associated Response Item for the pilot Hall Safety Climate Instrument.

Table 3.3 Operational Definitions of Safety Themes

Safety Theme	Definition
Management/supervisor attitude toward safety	How individuals perceive manager/supervisor commitment
Safety system	Policies, programs, equipment, etc. in place to protect individual
Risk	Individual’s assessment of danger
Work Pressure	Individual’s perceived priority of work vs. safety as set by others
Competence	Self-efficacy to follow safety procedures
Group Norms	Group climate influences an individual’s safety choices
Intention to follow Safety Procedures	Outcome measurement variable

Table 3.4 Safety Theme and Associated Response Item for the Pilot Hall Safety Climate Instrument

Safety Theme	Item
Manager/Supervisor	19. Management cares if I follow work safety procedures
	43. Management takes my personal safety seriously
	63. Managers only think about work safety if there has been an injury
	17. Management feels that work safety is a high priority
	37. Management discourages employees from not following work safety procedures
	10. Management cares if I follow safety procedures required by my job
	62. Management would respond quickly to my work safety concerns
	31. Supervisors talk to me about work safety
	40. Supervisors expect me to follow work safety procedures
	41. Supervisors are helpful if asked about work safety
	12. Supervisors listen to my ideas on how to improve work safety
	9. Supervisors devote sufficient effort to work safety
	56. Supervisors will know if I do not follow safety procedures required by my job
	48. Supervisors check to see if I am following safety procedures required by my job
	53. Supervisors regularly discuss work safety goals with me
Risk	60. I can do my job without following required safety procedures
	33. I use required safety equipment while doing my job
	23. I can work in unsafe conditions and not suffer an injury
	51. If I do not follow work safety procedures for my job, I will suffer an injury
	65. My job performance will be slower if I follow work safety procedures
	47. Safety procedures required by my job are not necessary to protect me from injury
	29. Safety procedures make my job safer
	18. My safety equipment protects me from injury even if I do not follow work safety procedures
	26. My job includes adequate safety procedures
	2. Increased work safety procedures would make my job safer

Table 3.4 Continued

Safety Theme	Item
Group Norms	8. I know other workers at my company that do not follow work safety procedures
	11. I will skip work safety procedures if I know other workers at my company are not watching
	16. I know workers at my company that can do their job without following work safety procedures
	13. I know workers at my company that do not care whether fellow workers are following safety procedures
	20. I am aware of departments at my company that do not care if work safety procedures are followed
	45. I know workers at my company that look out for each other
	7. I would report another workers who were not following safety procedures
Workplace Pressure	6. I feel that my productivity is more important than my safety
	46. Sometimes I will skip work safety procedures to get my job done
	35. Sometimes I am expected to do more work than I can safely do
	34. I will do whatever it takes to get the job done, even if it means ignoring work safety rules
Competence	44. I am clear about my responsibilities for job safety
	59. I understand safety procedures required by my job
	25. I understand the safety risks associated with my job
	57. The training I have received for my job has prepared me to work safely
	3. Sometimes I am unsure how to do my job safely
	1. My training enables me to recognize safety hazards at my job
	30. I am sure in my ability to work safely
	15. I pay attention to safety while doing my job
	5. I know how to report work safety hazards
	4. I know how to report work-related injuries

Table 3.4 Continued

Safety Theme	Item
Safety System	14. Incentive programs make me want to follow safety procedures required by my job
	50. Safety meetings give me information that helps me to work safely
	36. I am required to regularly attend work safety meetings
	49. If I have an idea to improve work safety, it will be considered by the company
	28. I am informed of new work safety procedures that will affect me
	52. If I violate safety procedures required by my job I will be disciplined
	58. If I reported a work safety hazard, someone would correct it
	38. I can get safety equipment that is required for my job
	39. Someone checks to see I use safety equipment if it is required by my job
	42. I check my work safety equipment regularly to see if it is working properly
	21. My work safety equipment is always in working order
	61. My work equipment is regularly maintained to reduce my exposure to safety hazards
	27. If I see equipment that is not in safe working order, I can have that equipment taken out of service
Intention	54. I would follow work safety procedures regardless if I thought it was necessary or not
	55. If I thought an area was unsafe I would check to see what additional safety measures were needed before I entered
	24. Before starting a task I make sure that I know all the work safety procedures that are required for that task
	22. If I don't know all the work safety hazards for a job, I will still do the job because that's what I'm being paid to do
	64. I would report any injury I suffered on the job
	32. I would report a work safety hazard if I was aware of one

Expert Content Item and Theme Validation Panel

A panel of experts was requested to assess face validity of the Hall Safety Climate Instrument, as well as the how the safety themes were selected to represent theory constructs. The panel was requested to review the item list, to assess the clarity of each response items and to comment on the validity of the item as it pertained to the related safety theme. Panel members only recommended minor changes in the wording of individual items such as: “If I reported a work safety hazard, it would be corrected” was changed to “If I reported a work safety hazard, someone would correct it”; and “My job can be done without following required safety procedures” was changed to “I can do my job without following required safety procedures”. Following these revisions the panel agreed that with the minor word changes the selected 65 items accurately reflected the selected seven safety themes.

Formatting the Pilot Hall Safety Climate Instrument

Following the expert Panel review a random sequence generator was used to determine the order of the individual 65 items included in pilot the Hall Safety Climate Instrument. The random sequence generator created a sequence of numbers that corresponded to the items. The four independent variables of: “Department”; “Job Level”; “Are there any hazards in your direct work area?”; and “At this or any previous place of employment have you ever been involved in a work-related accident that resulted in an injury?", were not submitted to determine random order. In order to accommodate the first four independent variable items the sequence generator was requested to begin with the number five and to end with the number sixty-nine. Once the response items were assigned a random sequence all items were formatted to fit on four page pilot version of the Hall Safety Climate Instrument.

Administration of the Pilot Hall Safety Climate Instrument

A steel mini-mill was selected for pilot testing to be conducted during January 2006. The facility was located in the southeastern part of the United States. There were 360 eligible participants that attended the monthly safety meetings where the pilot Hall Safety Climate Instrument was administered. The facility was similar in scope and nature of the intended field study population of mini-mill workers. The pilot instrument was administered by the safety manager for this plant location at the monthly safety meetings held for all departments. The on-site safety manager utilized standard procedures provided in writing by the researcher to introduce, administer and collect worker and on-site contractor responses to the pilot Hall safety climate. Appendix B provides a copy of all instructions and materials provided to the safety manager as well as copies of the pilot instrument. The survey packets were distributed by the on-site safety manager during regularly scheduled safety meetings which take place on a monthly basis for each group. In order to reach the approximate 360 individual workers a number of meetings are scheduled each week to accommodate workers from different work shifts and departments. A survey packet was distributed to each individual attending the safety meetings by the facility's safety manager. The safety manager had been instructed by the researcher to follow the written procedures provided for administering the survey pilot. This information was provided through an instruction sheet. The safety manager announced the anonymous survey and read a section that explained how the contributions of the participants would provide excellent information that will be used to refine an instrument to measure safety climate. All workers attending each meeting were invited to voluntarily participate in the research by completing the survey. The safety manager announced that it should take approximately 15 to 20 minutes to complete the survey. These instructions stressed that no identifying marks or numbers that might identify the individual were written on the surveys. Once the survey packets were distributed the safety manager also displayed a box that was used to collect the survey packets. The safety manager instructed everyone to please place the packet received in the box even if an individual worker chose not to complete the safety climate instrument. The box was located in an area that was obscured from direct observation by the safety manager. The safety manager designated one individual in each group to notify him when all members of the group have placed their packets in the box. At which time the safety manager entered the survey area and secured the box with shipping tape, labeled the location with shipping information and mailed the box to the researcher.

Pilot Hall Safety Climate Instrument Data Compilation and Analysis

When pilot data were received by mail from the pilot research site, participant responses were entered into an EXCEL database and imported into SPSS 14.0 for analysis. Returned surveys were screened for completion. A total of 317 responses were received from the pilot site. Following data entry all response instruments with any missing items were considered incomplete for analysis and removed from database. Five surveys did not meet the requirements of being "complete" and were excluded from analysis. The final response rate based on the number of total workers at the location and the number of instruments returned excluding the five incomplete surveys was 86.6%.

Determination of Safety Theme Scores

Safety theme scores were computed by first averaging the response item scores for the pilot Hall Safety Climate Instrument. Each average response item score was then grouped by the theme it was associated with. Group averages were computed and reported as the mean safety theme score. The mean safety theme scores were used for during the continued development of the Hall Pathway Model and the Hall Safety Climate Instrument.

However, fifteen individual response items in the pilot instrument were worded intentionally in a manner that required a reverse scoring function. A list of each of these fifteen items is provided in Table 3.5 entitled Preliminary Items of the Hall Safety Climate Instrument that Require Reverse Scoring.

Table 3.5 Preliminary Items of the Hall Safety Climate Instrument that Require Reverse Scoring

Item Number	Survey Item
3.	Sometimes I am unsure how to do my job safely
6.	I feel that my productivity is more important than my safety
8.	I know other workers at my company that do not follow work safety procedures
13.	I can work in unsafe conditions and not suffer an injury
16.	I know workers at my company that do not care whether fellow workers are following safety procedures
20.	I know workers at my company that can do their job without following work safety procedures
22.	I am aware of departments at my company that do not care if work safety procedures are followed
23.	I can work in unsafe conditions and not suffer an injury
34.	I will do whatever it takes to get the job done, even if it means ignoring work safety rules
35.	Sometimes I am expected to do more work than I can safely do
46.	Sometimes I will skip work safety procedures to get my job done
47.	Safety procedures required by my job are not necessary to protect me from injury
60.	I can do my job without following required safety procedures
63.	Managers only think about work safety if there has been an injury
65.	My job performance will be slower if I follow work safety procedures

For items requiring reverse scoring, a lower score translated into a higher safety climate. In order to be used in the mean score analysis the results of those items required a reverse score procedure.

Hall Pathway Model Analysis

AMOS 6.0 (Arbuckle, 2005) software package was used to test the fit of the Hall Pathway Model shown in Fig. 3.1 “Preliminary Pathway Model Developed by Mike Hall”, to the covariance matrix generated from the set of the seven safety themes.

The significance of the pathway analysis is that by demonstrating how the components of the model interact to yield the outcome of the model it can be shown that the instrument measures the outcome reliably. The theory of planned behavior model is used to illustrate how the theory constructs interact to get to the intention outcome.

For example, how a person arrives at the intention to display a behavior. By representing each of the three theory constructs with safety themes the idea is that if the safety themes accurately represent the theory constructs the interaction among the themes is associated with the person’s intention to follow safety behaviors. The Hall Safety Climate Instrument measures the responses of participants by the item scores grouped by themes. Items are associated with a specific safety theme and the grouping of items contributes to the mean score of the safety theme.

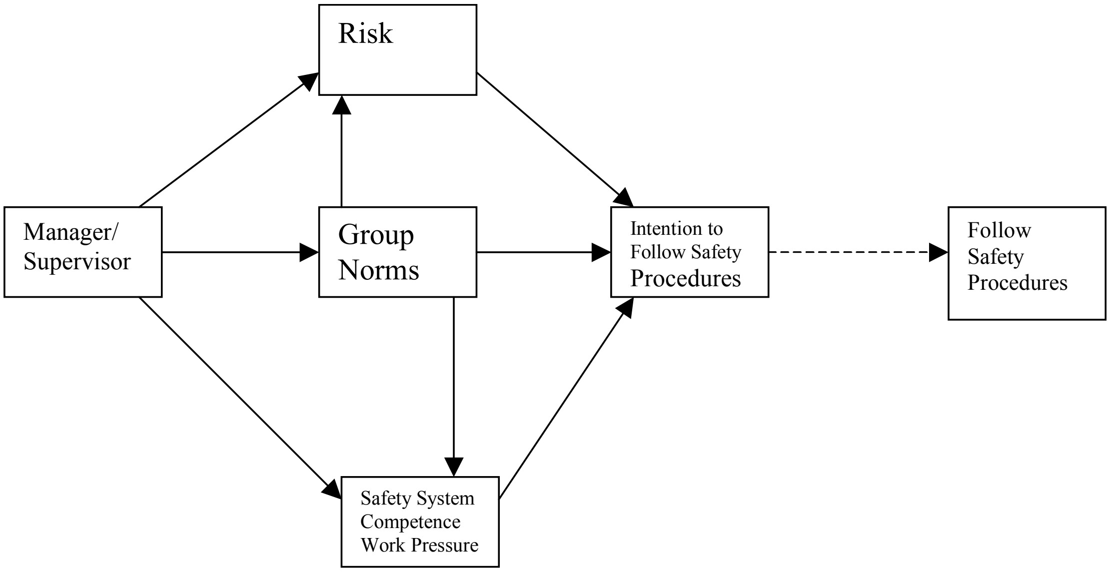

Fig. 3.1 Preliminary Pathway Model Developed by Mike Hall

The Hall Pathway Model was entered into the AMOS 6.0 program as a graphic representation and the pilot dataset was linked to the model. The safety theme mean scores were applied to the Hall Pathway Model and correlations and interactions were measured to determine model fit. One-way arrows were used to represent the effect of one variable on another. The fit statistics were observed to determine model fit. Model fit statistics were improved by using theoretical considerations to manipulate the one-way arrows within the model. A list of fit indices used for analysis is presented in Table 3.6 Fit Indices used for the Analysis of the Hall Pathway Model.

Theoretical considerations used to improve the fit of the model included: variable influences on other variables, and number of influences a variable receives. Modification to the pathway model can be accomplished within the software environment to achieve satisfactory model fit. Initial results of the Hall Pathway Model indicated an acceptable fit: χ^2 ratio to DF (n=312) = 93.59; GFI = .815; CFI = .764; TLI = -.179; RMSEA = .546.

Modification indices and theoretical considerations were used to modify the pathway model to achieve a better fit. The main changes were made to the contribution of Manager/Supervisor attitudes to intention to follow safety procedures. Additionally the contributions of risk and the construct of work pressure, competence and safety system on group norms was fixed. The resulting model is shown in Fig. 3.2 Modified Pathway Model Developed by Mike Hall.

Table 3.6 Fit Indices used for Analysis of the Hall Pathway Model

Fit Index	Acceptable Range
CMIN/DF	>3.0
GFI	.8 - .9
CFI	.8 - .9
TLI	.8 - .9
RMSEA	.5 - .7

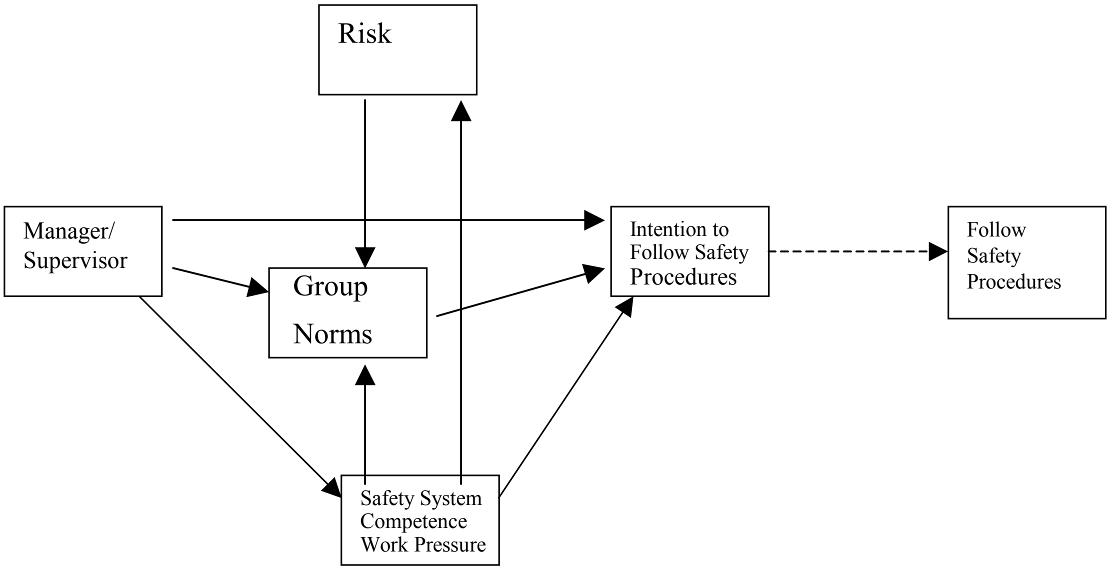

Fig. 3.2 Modified Pathway Model Developed by Mike Hall

Fit statistics for the resulting model were excellent: χ^2 ratio to DF (n=312) = 1.956; GFI = .995; CFI = .998; TLI = .988; RMSEA = .055 and all pathways were significant.

Summary

The Hall Pathway Model was designed to measure the fit of the safety themes influence on intention to follow safety procedures using AMOS 6.0. The preliminary analysis of the Hall Pathway Model had adequate fit for two of the criteria, GFI=.815 and RMSEA=.546. Adjusting the directional arrows to modify effects of variables on other variables the researcher was able to achieve acceptable fit statistics for all criteria, χ^2 ratio to DF (n=312) = 1.956; GFI = .995; CFI = .998; TLI = .988; RMSEA = .055 and all pathways were significant. Acceptable fit of the Hall Pathway Model is interpreted as the pilot Hall Safety Climate Instrument response items are correlated to the intention to follow safety procedures variable. Higher safety theme values are correlated to higher intention to follow safety procedures safety theme items. By demonstration of Hall Pathway Model fit, the researcher provides evidence to support the theory basis of the Hall Safety Climate Instrument design.

Internal Consistency Reliability Testing of the Pilot Hall Safety Climate Instrument

Cronbach's alpha was used to estimate internal consistency of the 65 response items. The Cronbach's Alpha tests the proportion of the total variance across all responses to individual items that are attributable to a common source of variance. A measure of the group reliability was determined by analyzing the overall alpha of the combined group of responses to items. A Cronbach's Alpha of .60 or greater was the criteria this study used to indicate if groups of item responses under one theme were reliable (Schmitt, 1996). The total alpha including all pilot participant responses to the 65 items was found to be .95 (n=312), which is well above the acceptable criteria. The reliability analysis included item response skewness. Item responses that were considered "highly skewed", greater than 1 or less than negative 1, in the distribution were omitted from the Hall Safety Climate Instrument. Highly skewed items were defined as those that have a high percentage of respondents selecting the same option for response creating a low response range (Williamson et al., 1997). Eleven items were found to be highly skewed, (<-1.00). These eleven items were discarded and not used in any further calculations. The Cronbach's Alpha was recalculated on the remaining 54 items after the eleven were removed. An acceptable Cronbach's Alpha of .93 was found (n=54).

Pilot Data: Factor Analysis Procedure

Determining the factors (latent variables) of the instrument helped lead to improving the understanding of the main influences contributing the overall safety climate as measured by the instrument. The 54 items were subjected to a factor analysis with principal component extraction and Varimax rotation. The scree plot generated from SPSS 14.0 yielded an interpretable solution of five factors, which accounted for

77.1% of variance. The final solution determined 34 items that loaded .4 or greater on only one factor. The criteria for response item selection were adapted from a study conducted by Williamson et al., (1997). Twenty items failed to load under these conditions on any factor. The remaining 34 items had a five factor structure. The first factor extracted was interpreted as “Understanding of safety program” because of the nature of the items that made up the factor. The second factor was interpreted as “Influence of Management and Supervisors” because it contained items that were related to the perceptions of management and supervisors. The third factor was interpreted as “Group beliefs” because the nature of the items dealt with the individual’s perception of the belief of others around them. The fourth factor was interpreted as “Risk acceptance” because the items focused on elements that may encourage risk behavior. The final factor was interpreted as “Intention to follow safety procedures” and the items contained addressed variables that contribute to an individual adhering to safety procedures. All factors contained at least three items and the internal consistency across items in each factor was acceptable for all. Additional measures to improve the Cronbach’s alpha for factors four and five were not conducted because further planned field testing of the instrument was designed to explore and confirm the factor structure. The factor Cronbach’s Alpha is presented in Table 3.7 Internal Consistency Reliability Analysis of Specific Safety Factors Within the Hall Safety Climate Instrument Pilot.

Table 3.7 Internal Consistency Reliability Analysis of Specific Safety Factors Within the Hall Safety Climate Instrument Pilot

Safety Factors	Variance	Cronbach's* Alpha	n
Understanding of safety program	45.664	.93	17
Influence of Management and Supervisors	15.443	.87	8
Group beliefs	5.505	.72	3
Risk acceptance	4.690	.60	3
Intention	5.764	.62	3

* round to two significant figures and none below .60 criteria

Field Testing of the Hall Safety Climate Instrument

This would be the initial trial of the newly created Hall Safety Climate Instrument. The researcher chose to consider the administration of this instrument as a field study and will include observations related to the research in Chapter VI. The Hall Safety Climate Instrument was administered at three steel mini-mills located in the United States owned by the same corporation. The operations conducted at each location were similar in scope and nature as the pilot location. The occupational hazards include: heat stress, molten steel, dark work conditions, heavy equipment use, noise, fast moving machinery, and scrap steel loading.

Summary of Procedures

The 34 items that were determined as valid and reliable from the pilot study were subjected to random sequencing. Once the random order was determined the final instrument was prepared for distribution. Each facility Safety Manger in the field study was contacted and provided a copy of the Hall Safety Climate Instrument, coversheet, and instruction sheet. Full copies of the Hall Safety Climate Instrument, coversheet, and instruction sheet are provided in Appendices B and C. The facilities made copies, administered, collected, and shipped the completed instruments to the researcher. The completed surveys would be entered into an Excel database and screened for incomplete surveys. After screening, the database was imported into SPSS 14.0 for factorial analysis. Analyses included: exploratory factor analysis (EFA) to determine a 5-factor, 4-factor, 3-factor, and 2-factor structure solution; confirmatory factor analysis (CFA) procedures were used to confirm which factor structure best fit the data from response items of the Hall Safety Climate Instrument; ANOVA and MANOVA procedures were used to explore group differences among the convenience sample; if differences were detected then post hoc analysis were performed using Tukey's HSD. The statistical procedures as related to the Research Objectives and Research Questions are presented in Table 3.8 List of Statistical Analyses Performed to Evaluate Each Research Objective/Question.

Instrument Design and Distribution Procedure

Study Approval and Confidentiality

The Institutional Review Board (IRB) at the University of Tennessee approved Form A and provided permission to proceed as the study did not include sensitive materials or vulnerable study groups. A certificate for exemption from IRB Review involving human subjects is on file in the Department of Instructional Technology, Health, and Cultural Studies at the University of Tennessee, Knoxville as noted in Appendix A.

Participants were assured in the study information sheet accompanying the questionnaire that participation was strictly voluntary and anonymous. A completed returned questionnaire served as consent to participate in the study. Permission to conduct the study was also obtained from management of the steel mini mill employer. The study information sheet and questionnaire are contained in Appendix B.

Table 3.8 List of Statistical Analyses Performed to Evaluate Each Research Objective/Question

Research Objective	Statistical Analysis
Develop a valid and reliable safety climate survey instrument, which is based on the theory of planned behavior, to assess the employees' perceptions of safety themes that contribute to the overall safety climate of a steel mini-mill employer located in the United States.	• Cronbach's Alpha • Factor Analysis • Pathway Analysis
Determine the safety climate of steel mini-mill of employees at three mill locations within the United States, using a valid and reliable safety climate survey instrument.	Descriptive statistics • frequency • mean
Research Questions	
What are the differences in the perceived safety climate of employees with different job positions working at three steel mini-mills in the United States	• ANOVA • MANOVA • Tukey's HSD
What are the differences in the perceived safety climate of employees working in different departments at three steel mini-mills in the United States	• ANOVA • MANOVA • Tukey's HSD
What are the differences in the perceived safety climate of employees that self-reported a previous work-related injury and those that reported no previous work-related injury at three steel mini-mills in the United States	• ANOVA • MANOVA
What are the differences in the perceived safety climate of employees that self-reported an awareness of a hazard in their immediate work area and those that reported no awareness of a hazard in their immediate work area at three steel mini-mills in the United States?	• ANOVA • MANOVA
What are the differences in the perceived safety climate of employees working in different geographic locations of three steel mini-mills in the United States?	• ANOVA • MANOVA • Tukey's HSD

Convenience Sample

The sample of convenience for this study was the employees and on-site contractors who worked at a steel mini-mill corporation with three locations in the United States. The workers at these locations perform job duties in a high-risk environment and depend greatly on safety programs to ensure their safety. Management is housed in a separate building from the manufacturing facility, and was suspected by the researcher to have a different point of view of day-to-day operations.

The potential study participants included all employees, including on-site contractors, working at these locations of the steel mini mill company. The total number of workers that were eligible for participation at the three steel mini-mills is listed in Table 3.9 Number of Eligible Participants for each Steel Mini-mill Location. Eligible participants are those that attended the safety meetings during the administration of the Hall Safety Climate Instrument. Those that were asked to voluntarily participate included: managers, supervisors, administrative personnel, laborers, and on-site contractors.

Final Instrument Distribution and Data Collection

Due to low generalizability of the study sample at the three locations and that this would be the initial administration of the newly created Hall Safety Climate Instrument, the data collected was considered part of a field study.

Table 3.9 Number of Eligible Participants for Each Steel Mini-Mill Location

Location	Number of Eligible Participants
No.1	383
No.2	302
No.3	270

The Hall Safety Climate Instrument was administered by the safety managers for each plant location at the monthly safety meetings held for all departments. The on-site safety managers utilized standard procedures provided in writing by the researcher to introduce, administer and collect worker and on-site contractor responses to the Hall Safety Climate Instrument. Appendices B and D provide a copy of all instructions and materials provided to the Safety managers as well as copies of the Hall Safety Climate Instrument. The survey packets were distributed, by the on-site safety manager, during regularly scheduled safety meetings which take place on a monthly basis for each group. In order to reach the approximate 955 individual workers a number of meetings are scheduled each week to accommodate workers from different work shifts and departments. A survey packet was distributed to each individual attending the safety meetings by the facilities' safety manager. The safety managers had been instructed by the researcher to follow the written procedures provided for administering the survey pilot. This information was provided through an instruction sheet. The safety managers announced the anonymous survey and read a section that explained how the contributions of the participants would provide excellent information that will be used to refine an instrument to measure safety climate. All workers attending each meeting were invited to voluntarily participate in the research by completing the survey. The safety managers announced that it should take approximately 15 minutes to complete the survey. These instructions stressed that no identifying marks or numbers that might identify the individual were written on the surveys. Once the survey packets were distributed the safety managers also displayed a box that was used to collect the survey packets. The safety managers instructed everyone to please place the packet received in the box even if an individual worker chose not to complete the safety climate instrument. The box was located in an area that was obscured from direct observation by the Safety Managers. The Safety Managers designated one individual in each group to notify them when all members of the group have placed their packets in the box. At which time the Safety Managers entered the survey area and secured the box with shipping tape, labeled the location with shipping information and mailed the box to the researcher.

Selected items are reverse scored due to a negative relationship of the item score. A list of response items requiring reverse scoring is presented in Table 3.10 Final Items of the Hall Safety Climate Instrument that Require Reverse Scoring. All the item scores are computed and the total item mean score is used as a measure of safety climate. In order to facilitate confirmatory factor analysis (CFA) the researcher developed 5-factor, 4-factor, 3-factor and 2-factor solutions using the appropriate procedures in SPSS. The factor solution is assigned items by selecting only those items that loaded at >.4 on only one factor. Items that loaded on a factor based on the 5-factor, 4-factor, 3-factor or 2-factor solutions were averaged and the results are used to perform the CFA.

Confirmatory Factor Analysis of Field Study Data

The confirmatory factor analysis (CFA) is performed on each of the four factor solutions determined by the researcher. Using AMOS 6.0 the researcher created a structural equation model for each of the four factor solutions. The dataset was linked to each model and the analysis was performed. Fit indices were used to determine the best factor solution fit.

Table 3.10 Final Items of the Hall Safety Climate Instrument that Require Reverse Scoring

Item No.	Response Item
16	Sometimes I will skip work safety procedures to get my job done
17	My job performance will be slower if I follow work safety procedures
21	I know workers at my company that can do their job without following work safety procedures
22	I am aware of departments at my company that do not care if work safety procedures are followed
26	Sometimes I am unsure how to do my job safely
27	I can work in unsafe conditions and not suffer an injury
29	If I don’t know all the work safety hazards for a job, I will still do the job because that’s what I’m being paid to do
31	Safety procedures required by my job are not necessary to protect me from injury
34	Sometimes I am expected to do more work than I can safely do
36	I know other workers at my company that do not follow work safety procedures
38	I will do whatever it takes to get the job done, even if it means ignoring work safety rules

Model fit can be improved by using the modification index provided by AMOS 6.0 but caution is to be exercised in order to avoid “overfit” of the data to the model. “Overfitting” of the model would be to make changes to the SEM strictly for the benefit of achieve higher fit statistics with no regard for theoretical considerations. Use of the modification index marks the end of the CFA as this method of fit improvement is exploratory in nature.

Safety Climate and Safety Factor Mean Score Group Differences

Group differences in safety climate and safety factor scores were determined by analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA). Significant differences ($p<0.05$) among variables were identified when the F ratio indicated larger variance among variables than within variables. Post hoc comparisons were performed to determine the specific groups that yielded the significant differences. Pairwise correlations, specifically Tukey’s Honestly Significant Difference (Tukey’s HSD), were computed to determine which groups differed the most in self-reported perceptions of safety climate.

Criteria of Safety Climate Assessment

For the purpose of this study the researcher established criteria for evaluation of safety climate, safety factor, and item mean scores. Scores equal to or greater than 3 are classified as “high”, scores below 3 are considered “low”. These classifications are not intended to be used as performance measures. They are strictly observational measures for study purposes. The researcher suggests that an action level be set at <3.0 for safety climate and safety factor mean score. This action level would alert safety personnel to safety climates or safety factors that require further investigation as to why the individuals are scoring the items lower than 3. This action level is not intended to be used with item scores as it is applied to safety climate and safety factor scores. Individual items contribute to an overall factor reliability and should be considered only as a contributor to a safety factor score. However, any item that scores below the action level could be considered for further thought during safety program planning. The action level is not intended as a method of measuring overall performance of the safety program; rather it is to be used as an indicator for further research. The rationale for the action level is that items scored with a 1 or 2 (after reverse scoring appropriate items) indicates a negative connotation (*Strongly Disagree* or *Disagree*) and should be investigated further.

Summary

The methodology used in the study has been described in this chapter. The convenience sample consisted of the U.S. employees of three steel mini-mill locations. The responses to the survey were collected and entered into a spreadsheet designed by the researcher, and analyzed using SPSS 14.0. Statistical analysis included mean score calculation, factor analysis, reliabilities, pathway model fit, sequential equation modeling, ANOVA and MANOVA tests with a significance level of 0.05. The variables used in this study were defined and discussed as they related to the instrument. The development of the instrument in regards to designed use of safety themes to indirectly measure theory constructs was discussed. Instrumentation validity and reliability were discussed. In separate sections the data collection process, data management, and analysis of the data were discussed. In the following chapter (Chapter IV) presentation of specific results and conclusions to address the research objectives presented in Chapter I.

CHAPTER IV

ANALYSIS OF DATA

Introduction

Chapter four presents the statistical analysis and results of the Hall Safety Climate Instrument data following the field test at three steel mini-mill corporate locations. The survey response rate is discussed and descriptive data is given for variables including: location, job position, department, prior experience with work-related injury, and awareness of hazard in immediate work area. Statistical analysis of group differences in perceived safety climate and safety factor score by job position, department, and geographic work location were analyzed using ANOVA and MANOVA procedures, if any differences were detected post hoc analysis using Tukey's HSD was performed. Group differences in prior experience with work-related injury, awareness of hazard in immediate work area were analyzed using ANOVA and MANOVA procedures.

Field Instrument Development Summary

The 65 response item pilot Hall Safety Climate Instrument was administered at a location that was similar in scope and nature as the field test locations. The pilot Hall Safety Climate Instrument was administered during monthly safety meetings. The Safety Manager followed a prescribed methodology to administer and collect the surveys. After receiving and entering the survey responses, five incomplete surveys were excluded. The 65 response items were reduced to 54 items after eliminating items because of skewness of responses. Factor analysis procedures eliminated 20 response items that did not meet factor criteria.

Descriptive Demographics

Survey Response Rate by Location

Survey responses totaled 671 out of a possible 955 which yielded a response rate of 70.3%. The response rates for the three survey locations are as follows: location No.1 (73.1%); location No.2 (64.6%) and location No.3 (72.6%). The number of eligible participants and number of completed survey are presented in Table 4.1 Response Rate of Completed Surveys of the Hall Safety Climate Instrument Field Study.

Survey Response Rate by Department and Job Position

Department and job position were self-reported. The 671 respondents were from three work locations: locations No.1, No.2 and No.3. The job position categories for the field study of the Hall Safety Climate Instrument were: (1) Manager; (2) Supervisor; (3) Administration; and (4) Non-exempt. Response rate for completed surveys for job position ranged from 3.9 to 82.1 percent. Response rate for completed surveys by job position is presented in Table 4.2 Self-Reported Department of Respondents at Steel Mini-Mill Locations Participating in the Hall Safety Climate Instrument Field Study.

Table 4.1 Response Rate of Completed Surveys of the Hall Safety Climate Instrument Field Study

Field Study Location	Number of Eligible Participants	Completed Surveys	Response Rate	Cumulative Percentage
No.1	383	280*	73.1	41.7
No.2	302	195**	64.6	70.9
No.3	270	196	72.6	100.0
Total	955	671	70.2	

* three surveys incomplete and excluded from analysis

** one survey incomplete and excluded from analysis

Table 4.2 Self-Reported Department of Respondents at Steel Mini-Mill Locations Participating in the Hall Safety Climate Instrument Field Study

Self-Reported Department	Number of Respondents by Department	Response Rate	Cumulative Percentage
Melt Shop	227	33.8	33.8
Rolling Mill	183	27.3	61.1
Maintenance	116	17.3	78.4
Administration	90	13.4	91.8
Contractors	55	8.2	100.0
Total	671	100.0	

The department categories for the field study of the Hall Safety Climate Instrument were: (1) Melt Shop; (2) Rolling Mill; (3) Maintenance; (4) Administration; and (5) Contractor. Response rate for department ranged from 8.2 to 33.8 percent. Response rate for completed surveys by department is presented in Table 4.3 Self-Reported Job Position of Respondents at Steel Mini-Mill Locations Participating in the Hall Safety Climate Instrument Field Study.

Survey Response by Prior Work-Related Injury

Employees who self-reported prior work-related injury experience at the present or any previous place of employment was 564 or 84.1 percent. The number of respondents for each response is listed in Table 4.4 Self-Reported Prior Work-Related Injury Experience of Respondents at Steel Mini-Mill Locations Participating in the Hall Safety Climate Instrument Field Study.

Survey Response Rate of Self-Reported Hazard in Immediate Work Area

The number of employees that self-reported having an awareness of a hazard in their immediate work area was 444 or 66.2 percent. The number of respondents for each response is listed in Table 4.5 Self-Reported Awareness of Hazard in Immediate Work Area of Respondents at Steel Mini-Mill Locations Participating in the Hall Safety Climate Instrument Field Study.

Table 4.3 Self-Reported Job Position of Respondents at Steel Mini-Mill Locations Participating in the Hall Safety Climate Instrument Field Study

Self-Reported Job Position	Number of Respondents by Job Position	Response Rate	Cumulative Percentage
Manager	26	3.9	3.9
Supervisor	53	7.9	11.8
Employee	551	82.1	93.9
Non-exempt	41	6.1	100.0
Total	671	100.0	

Table 4.4 Self-Reported Prior Work-Related Injury Experience of Respondents at Steel Mini-Mill Locations Participating in the Hall Safety Climate Instrument Field Study

Self-Reported Injury Experience	Number of Respondents	Response Rate	Cumulative Percentage
“NO”	107	15.9	15.9
“YES”	564	84.1	100.0
Total	671	100.0	

Table 4.5 Self-Reported Awareness of Hazard in Immediate Work Area of Respondents at Steel Mini-Mill Locations Participating in the Hall Safety Climate Instrument Field Study

Self-Reported Hazard Awareness	Number of Respondents	Response Rate	Cumulative Percentage
“NO”	227	33.8	33.8
“YES”	444	66.2	100.0
Total	671	100.0	

Statistics

The procedures for administering and collecting the Hall Safety Climate Instrument were discussed between the facility safety manager and the researcher. A cover sheet that explained the scope and purpose of the research and that participation was strictly voluntary and anonymous was included in the electronic transmission of the document. Once the safety manager received the document copies were made for distribution to the convenience sample of employees. Completed surveys were collected and shipped to the researcher.

The responses to the Hall Safety Climate Instrument were transferred to an Excel spreadsheet by the researcher. Quality assurance was insured by checking entered data against survey responses. The Excel data file was transferred into a Statistical Package for the Social Sciences (SPSS), version 14.0 data file to run statistical analysis.

Returned surveys were screened for completion. Any surveys with missing data were considered incomplete. Due to the low number of incomplete surveys the researcher decided to exclude them from analysis.

Final Instrument Internal Consistency Reliability

The 34 items were checked for internal consistency by observing the overall Cronbach's alpha, .915 (n=34). A factor analysis using principal component extraction with Varimax rotation was used to determine the underlying factor structure. A scree plot suggested a five factor structure. The scree plot from the SPSS analysis is presented in Fig. 4.1 Scree Plot of Eigenvalues for the Hall Safety Climate Instrument Field Study.

Response items from the Hall Safety Climate Instrument were assigned to a factor if they loaded greater than .4 on only one factor. The final five-factor structure included 29 response items that met the criteria for factor assignment. Five items loaded above .4 but did on two or more factors and were discarded. To further investigate other possibilities for factor structure, the factor analysis was restricted to 4, 3 and 2 factor solutions. Each of the four structures was to be tested during the confirmatory factor analysis (CFA) portion of the results section.

Confirmatory Factor Analysis of Hall Safety Climate Instrument Field Study Data

Structural Equation Modeling (SEM), using AMOS 6.0 was used to test the hypothesized models of the relationships among the instrument variables. The choice of fit indices in SEM was determined by literature review of similar studies (Fogarty and Shaw 2004). The fit indices selected were (indicates acceptable value): the ratio of χ^2 to degrees freedom (<3); Good Fit Index, GFI (>.9); Comparative Fit Index, CFI (>.9); Tucker-Lewis Index, TLI (>.9); and Root Mean Square Error of Approximation, RMSEA (>.05, <.08).

The three factor model exhibited the best fit; CMIN/DF = 3.197; GFI = .894; CFI = .889; TLI = .878; RMSEA = .057.

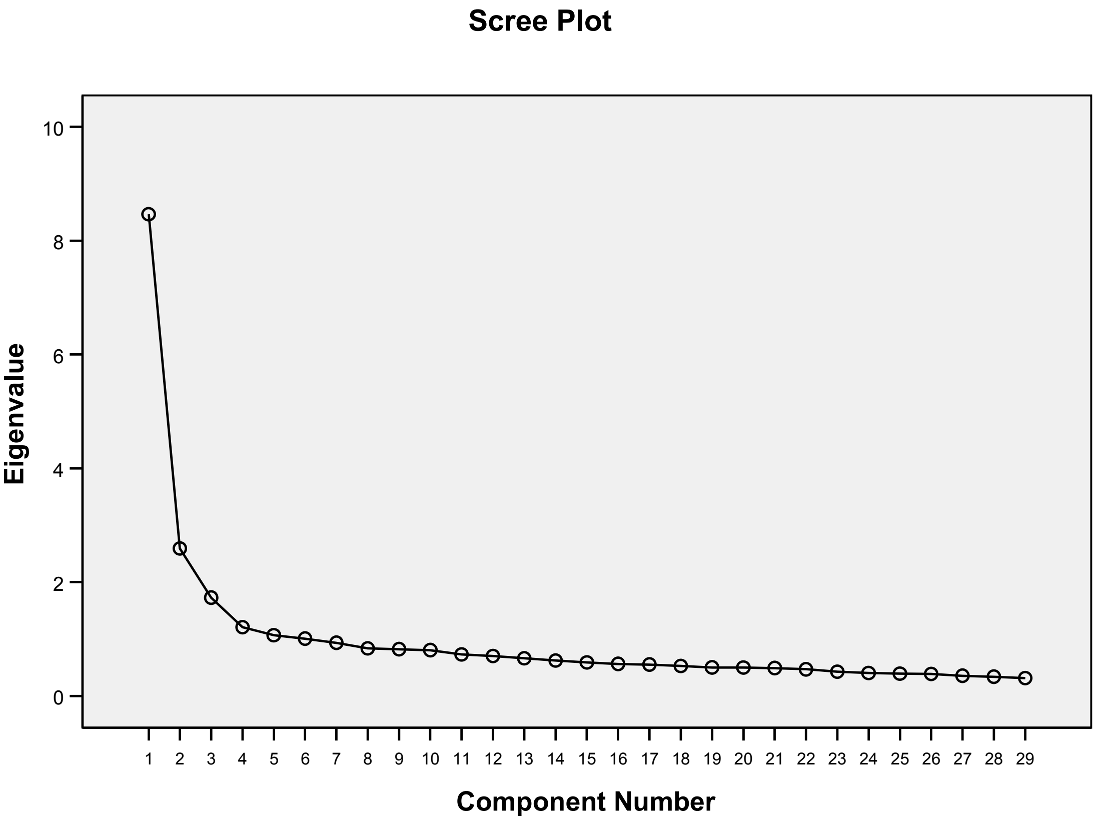

Fig. 4.1 Scree Plot of Eigenvalues for the Hall Safety Climate Instrument Field Study

A graphical representation of the three factor structure is presented in Fig. 4.2 Preliminary Hall Safety Climate Instrument Field Data Structural Equation Model Developed by Mike Hall.

The oval objects are the factors, the double-headed arrows reflect the interaction among factors, the one way arrows indicate influence on the rectangles which represents the response items, and the circles represent error variables that are assigned by the AMOS 6.0 software.

The modification index was selected as an output option in AMOS 6.0. The large values reported by the modification index may indicate the presence of factor cross-loading and error covariances (Fogarty and Shaw 2004).

At this point further modification of the model becomes exploratory in nature even though CFA procedures are continued. Items that have large modification index values were reviewed for wording and any similarity in meaning with other items. Based on the reported value and theoretical considerations five items were discarded from the three factor model to yield a modified structural equation model. The items deleted to improve the fit statistics of the three factor model are presented in Table 4.6 Items Deleted from the Hall Safety Climate Instrument Following Modification Index Review.

The modified model fit was achieved in 10 iterations and exhibited excellent fit statistics: CMIN/DF = 2.876; GFI = .919; CFI = .913; TLI = .903; RMSEA = .053. The resulting model is shown in Fig. 4.3. Modified Hall Safety Climate Instrument Field Data Structural Equation Model Developed by Mike Hall.

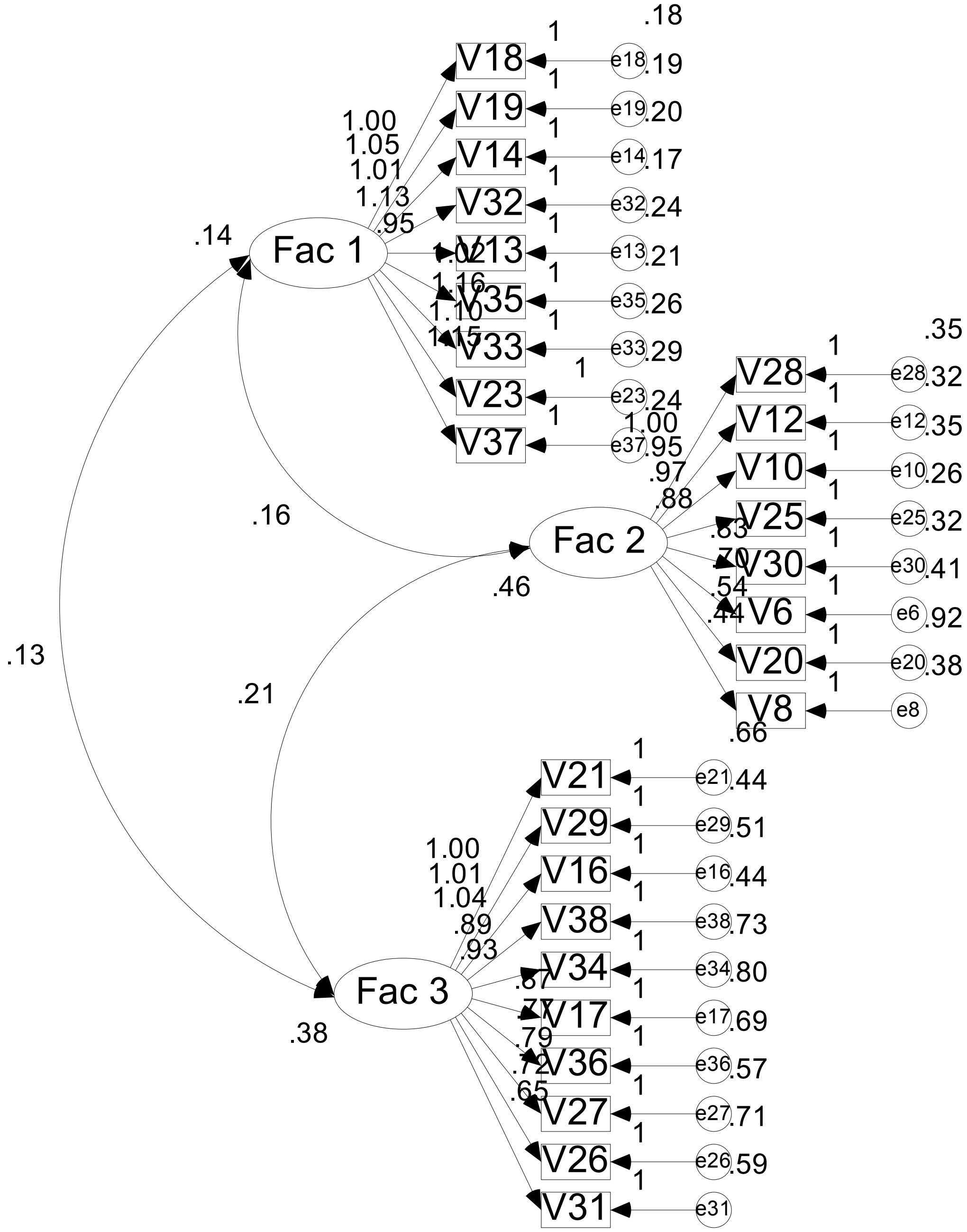

Fig. 4.2 Preliminary Hall Safety Climate Instrument Field Data Structural Equation Model Developed by Mike Hall

Table 4.6 Items Deleted from the Hall Safety Climate Instrument Following Modification Index Review

Safety Factor	Item No.	Response Item
Risk Taking Behaviors	38	I understand the safety risks associated with my job
Risk Taking Behaviors	36	If I thought an area was unsafe I would check to see what additional safety measures were needed before I entered
Manager/Supervisor Support	10	Management would respond quickly to my work safety concerns
Safety System Program	14	I know other workers at my company that do not follow work safety procedures
Safety System Program	33	I will do whatever it takes to get the job done, even if it means ignoring work safety rules

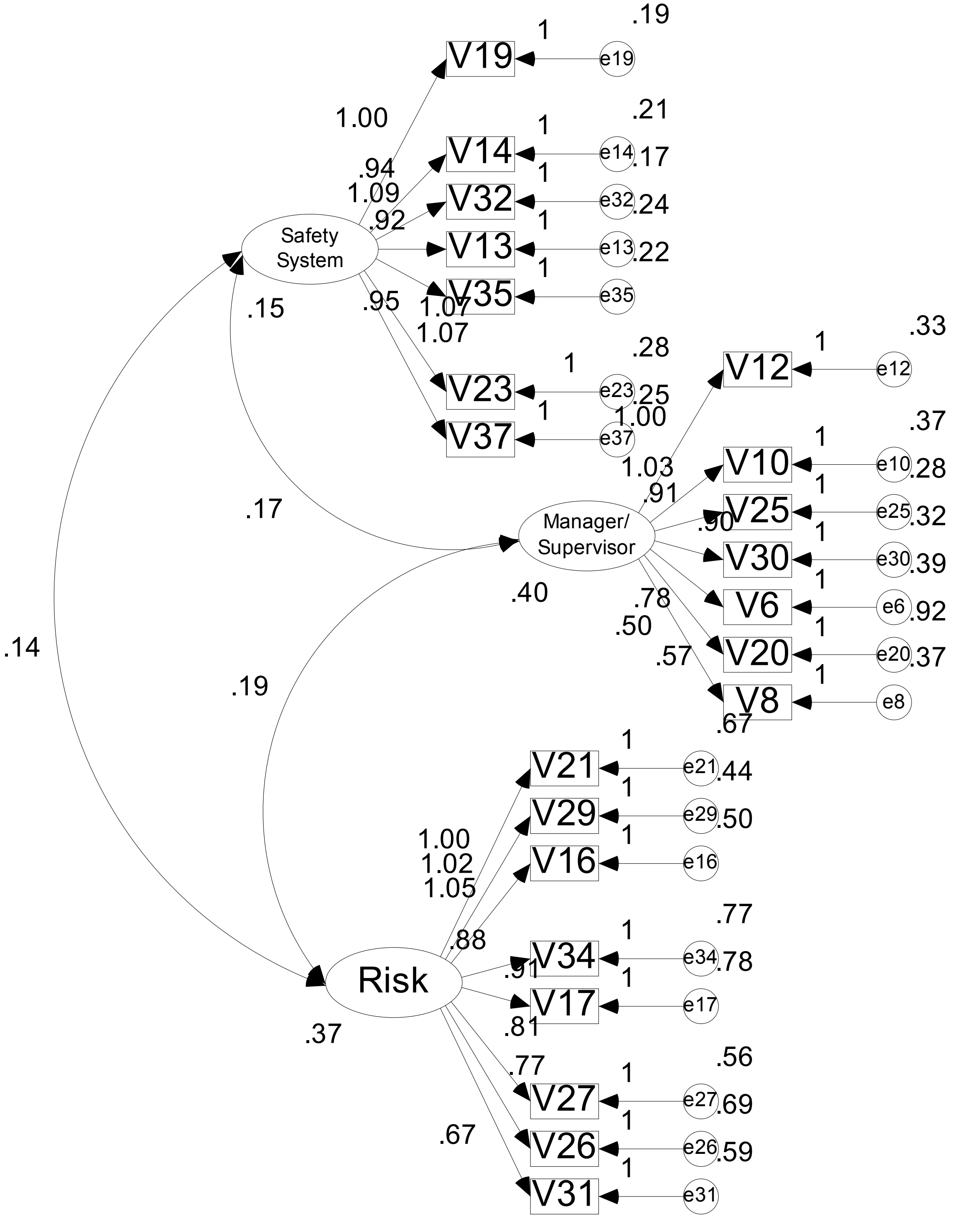

Fig. 4.3 Modified Hall Safety Climate Instrument Field Data Structural Equation Model Developed by Mike Hall

Safety Climate and Safety Factor Mean Scores

Individual data analyses were conducted to investigate the research questions to determine if significant differences exist between the independent variables. The independent variables were analyzed by comparing the safety climate mean scores and individual safety factor mean scores using analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA). If a significant difference was detected during the MANOVA further analysis using post hoc tests, specifically Tukey's HSD, were conducted to determine the specific differences. The item mean scores, individual safety factor scores, and the overall safety climate score for all plants combined are presented in Table 4.7 Safety Climate, Safety Factor, and Individual Hall Safety Climate Instrument Item Mean Scores for All Steel Mini-Mill Locations.

Each location was analyzed separately to report item mean scores, individual safety factor scores, and overall safety climate score which are presented in Tables 4.8 Safety Climate, Safety Factor, and Individual Hall Safety Climate Instrument Item Mean Scores for Steel Mini-Mill Location No.1, 4.9 Safety Climate, Safety Factor, and Individual Hall Safety Climate Instrument Item Mean Scores for Steel Mini-Mill Location No.2 and 4.10 Safety Climate, Safety Factor, and Individual Hall Safety Climate Instrument Item Mean Scores for Steel Mini-Mill Location No.3.

Table 4.7 Safety Climate, Safety Factor, and Individual Hall Safety Climate Instrument Item Mean Scores for All Steel Mini-Mill Locations

Safety Factor No. 1	Safety System Program – The individual understands the importance of safety procedures	Mean Score
Item 18	I understand the safety risks associated with my job	4.12
Item 19	I know how to report work-related injuries	4.06
Item 14	I use required safety equipment while doing my job	4.19
Item 32	I understand safety procedures required by my job	3.98
Item 13	I check my work safety equipment regularly to see if it is working properly	4.02
Item 35	I am clear about my responsibilities for job safety	3.96
Item 33	If I thought an area was unsafe I would check to see what additional safety measures were needed before I entered	4.01
Item 23	Before starting a task I make sure that I know all the work safety procedures that are required for that task	3.79
Item 37	I would report a work safety hazard if I was aware of one	4.06
Total Factor Score for "Safety System Program"		4.0235
Safety Factor No. 2	Management/Supervisor Support – The individual perceives that the safety culture is supported by superiors	
Item 28	Management would respond quickly to my work safety concerns	3.52
Item 12	If I reported a work safety hazard, someone would correct it	3.63
Item 10	Management takes my personal safety seriously	3.94
Item 25	If I have an idea to improve work safety, it will be considered by the company	3.75
Item 30	Supervisors devote sufficient effort to work safety	3.66
Item 6	Supervisors regularly discuss work safety goals with me	3.82
Item 20	Supervisors listen to my ideas on how to improve work safety	3.30
Item 8	I know workers at my company that look out for each other	4.10
Total Factor Score for "Management/ Supervisor Support"		3.7144

Table 4.7 Continued

Safety Factor No.3	Risk Taking Behaviors – The individual attitude toward risk taking behaviors while performing duties associated with work	Mean Score
Item 21	I know workers at my company that can do their job without following work safety procedures *	3.31
Item 29	If I don't know all the work safety hazards for a job, I will still do the job because that's what I'm being paid to do *	3.51
Item 16	Sometimes I will skip work safety procedures to get my job done *	3.68
Item 38	I will do whatever it takes to get the job done, even if it means ignoring work safety rules *	3.99
Item 34	Sometimes I am expected to do more work than I can safely do *	3.08
Item 17	My job performance will be slower if I follow work safety procedures *	3.01
Item 36	I know other workers at my company that do not follow work safety procedures *	2.93 **
Item 27	I can work in unsafe conditions and not suffer an injury *	3.70
Item 26	Sometimes I am unsure how to do my job safely *	3.48
Item 31	Safety procedures required by my job are not necessary to protect me from injury *	3.74
Total Factor Score for "Risk Taking Behaviors"		3.4432
Safety Climate Score		3.753

* indicates that item was reverse scored before analysis

** item mean score is below the action level

Table 4.8 Safety Climate, Safety Factor, and Individual Hall Safety Climate Instrument Item Mean Scores for Steel Mini-Mill Location No.1

Safety Factor No. 1	Safety System Program – The individual understands the importance of safety procedures	Mean Score
Item 18	I understand the safety risks associated with my job	4.16
Item 19	I know how to report work-related injuries	4.15
Item 14	I use required safety equipment while doing my job	4.25
Item 32	I understand safety procedures required by my job	4.09
Item 13	I check my work safety equipment regularly to see if it is working properly	4.06
Item 35	I am clear about my responsibilities for job safety	4.06
Item 33	If I thought an area was unsafe I would check to see what additional safety measures were needed before I entered	4.08
Item 23	Before starting a task I make sure that I know all the work safety procedures that are required for that task	3.90
Item 37	I would report a work safety hazard if I was aware of one	4.19
Total Factor Score for "Safety System Program"		4.1079
Safety Factor No.2	Management/Supervisor Support – The individual perceives that the safety culture is supported by superiors	
Item 28	Management would respond quickly to my work safety concerns	3.78
Item 12	If I reported a work safety hazard, someone would correct it	3.84
Item 10	Management takes my personal safety seriously	4.22
Item 25	If I have an idea to improve work safety, it will be considered by the company	3.94
Item 30	Supervisors devote sufficient effort to work safety	3.90
Item 6	Supervisors regularly discuss work safety goals with me	4.02
Item 20	Supervisors listen to my ideas on how to improve work safety	3.94
Item 8	I know workers at my company that look out for each other	4.23
Total Factor Score for "Management/ Supervisor Support"		3.9826

Table 4.8 Continued

Safety Factor No.3	Risk Taking Behaviors – The individual has an understanding of what safety procedures are necessary in order to avoid risk taking behavior	Mean Score
Item 21	I know workers at my company that can do their job without following work safety procedures *	3.46
Item 29	If I don't know all the work safety hazards for a job, I will still do the job because that's what I'm being paid to do *	3.68
Item 16	Sometimes I will skip work safety procedures to get my job done *	3.79
Item 38	I will do whatever it takes to get the job done, even if it means ignoring work safety rules *	4.07
Item 34	Sometimes I am expected to do more work than I can safely do *	3.30
Item 17	My job performance will be slower if I follow work safety procedures *	3.20
Item 36	I know other workers at my company that do not follow work safety procedures *	3.01
Item 27	I can work in unsafe conditions and not suffer an injury *	3.79
Item 26	Sometimes I am unsure how to do my job safely *	3.63
Item 31	Safety procedures required by my job are not necessary to protect me from injury *	3.84
Total Factor Score for "Risk Taking Behaviors"		3.5768
Safety Climate Score		3.909

* indicates that item was reverse scored before analysis

** item mean score is below the action level

Table 4.9 Safety Climate, Safety Factor, and Individual Hall Safety Climate Instrument Item Mean Scores for Steel Mini-Mill Location No.2

Safety Factor No.1	Safety System Program– The individual understands the importance of safety procedures	Mean Score
Item 18	I understand the safety risks associated with my job	4.08
Item 19	I know how to report work-related injuries	4.03
Item 14	I use required safety equipment while doing my job	4.16
Item 32	I understand safety procedures required by my job	3.88
Item 13	I check my work safety equipment regularly to see if it is working properly	3.99
Item 35	I am clear about my responsibilities for job safety	3.87
Item 33	If I thought an area was unsafe I would check to see what additional safety measures were needed before I entered	4.03
Item 23	Before starting a task I make sure that I know all the work safety procedures that are required for that task	3.80
Item 37	I would report a work safety hazard if I was aware of one	4.06
Total Factor Score for “Safety System Program”		3.9898
Safety Factor No.2	Management/Supervisor Support – The individual perceives that the safety culture is supported by superiors	
Item 28	Management would respond quickly to my work safety concerns	3.45
Item 12	If I reported a work safety hazard, someone would correct it	3.53
Item 10	Management takes my personal safety seriously	4.01
Item 25	If I have an idea to improve work safety, it will be considered by the company	3.80
Item 30	Supervisors devote sufficient effort to work safety	3.58
Item 6	Supervisors regularly discuss work safety goals with me	3.68
Item 20	Supervisors listen to my ideas on how to improve work safety	2.25 **
Item 8	I know workers at my company that look out for each other	3.96
Total Factor Score for “Management/ Supervisor Support”		3.5332

Table 4.9 Continued

Safety Factor No.3	Risk Taking Behaviors – The individual has an understanding of what safety procedures are necessary in order to avoid risk taking behavior	Mean Scores
Item 21	I know workers at my company that can do their job without following work safety procedures *	3.29
Item 29	If I don't know all the work safety hazards for a job, I will still do the job because that's what I'm being paid to do *	3.56
Item 16	Sometimes I will skip work safety procedures to get my job done *	3.77
Item 38	I will do whatever it takes to get the job done, even if it means ignoring work safety rules *	4.10
Item 34	Sometimes I am expected to do more work than I can safely do *	2.94 **
Item 17	My job performance will be slower if I follow work safety procedures *	2.90 **
Item 36	I know other workers at my company that do not follow work safety procedures *	3.00
Item 27	I can work in unsafe conditions and not suffer an injury *	3.74
Item 26	Sometimes I am unsure how to do my job safely *	3.20
Item 31	Safety procedures required by my job are not necessary to protect me from injury *	3.66
Total Factor Score for "Risk Taking Behaviors"		3.4163
Safety Climate Score		3.671

* indicates that item was reverse scored before analysis

** item mean score is below the action level

Table 4.10 Safety Climate, Safety Factor, and Individual Hall Safety Climate Instrument Item Mean Scores for Steel Mini-Mill Location No.3

Safety Factor No. 1	Safety System Program– The individual understands the importance of safety procedures	Mean Score
Item 18	I understand the safety risks associated with my job	4.11
Item 19	I know how to report work-related injuries	3.96
Item 14	I use required safety equipment while doing my job	4.12
Item 32	I understand safety procedures required by my job	3.92
Item 13	I check my work safety equipment regularly to see if it is working properly	3.98
Item 35	I am clear about my responsibilities for job safety	3.90
Item 33	If I thought an area was unsafe I would check to see what additional safety measures were needed before I entered	3.90
Item 23	Before starting a task I make sure that I know all the work safety procedures that are required for that task	3.64
Item 37	I would report a work safety hazard if I was aware of one	3.89
Total Factor Score for "Safety System Program"		3.9362
Safety Factor No.2	Management/Supervisor – The individual perceives that the safety culture is supported by superiors	
Item 28	Management would respond quickly to my work safety concerns	3.21
Item 12	If I reported a work safety hazard, someone would correct it	3.43
Item 10	Management takes my personal safety seriously	3.48
Item 25	If I have an idea to improve work safety, it will be considered by the company	3.42
Item 30	Supervisors devote sufficient effort to work safety	3.39
Item 6	Supervisors regularly discuss work safety goals with me	3.67
Item 20	Supervisors listen to my ideas on how to improve work safety	3.45
Item 8	I know workers at my company that look out for each other	4.04
Total Factor Score for "Management/ Supervisor Support"		3.5115

Table 4.10 Continued

Safety Factor No.3	Risk – The individual has an understanding of what safety procedures are necessary in order to avoid risk taking behavior	Mean Score
Item 21	I know workers at my company that can do their job without following work safety procedures *	3.12
Item 29	If I don't know all the work safety hazards for a job, I will still do the job because that's what I'm being paid to do *	3.21
Item 16	Sometimes I will skip work safety procedures to get my job done *	3.45
Item 38	I will do whatever it takes to get the job done, even if it means ignoring work safety rules *	3.77
Item 34	Sometimes I am expected to do more work than I can safely do *	2.89 **
Item 17	My job performance will be slower if I follow work safety procedures *	2.86 **
Item 36	I know other workers at my company that do not follow work safety procedures *	2.74 **
Item 27	I can work in unsafe conditions and not suffer an injury *	3.52
Item 26	Sometimes I am unsure how to do my job safely *	3.55
Item 31	Safety procedures required by my job are not necessary to protect me from injury *	3.67
Total Factor Score for "Risk Taking Behaviors"		3.2785
Safety Climate Score		3.611

* indicates that item was reverse scored before analysis

** item mean score is below the action level

Safety Climate and Safety Factor Mean Scores by Job Position

ANOVA analyses were conducted to determine if there was a significant difference in self-reported job position and overall safety climate. Self-reported job position was the independent variable and was compared to the average overall score of the instrument. Job position categories included: (1) Manager; (2) Supervisor; (3) Employee; and (4) Non-exempt.

ANOVA analysis detected significant differences at a p=.05 level in responses to job position and overall safety climate. The ANOVA F value was $F_{(3,667)}=14.57$, p=.001, indicating significant differences between job positions and overall safety climate. Post hoc analysis was performed based on the significant differences found using Tukey's HSD. Job positions *Employee* and *Non-exempt* scored significantly lower than job positions *Manager* and *Supervisor*. Safety climate mean scores for job position are presented in Table 4.11 Job Position Safety Climate Mean Scores from the Hall Safety Climate Instrument Field Study.

MANOVA analyses were conducted to determine if significant differences existed between self-reported job positions and individual safety factor scores. Self-reported job position was the independent variable and was compared to individual safety factor scores.

MANOVA analysis detected significant differences at a p=.05 level in job position and individual safety factor scores.

Table 4.11 Job Position Safety Climate Mean Scores from the Hall Safety Climate Instrument Field Study

Self-Reported Job Position	Number of Respondents	Mean	Std. Dev.	Std. Error	Min.	Max.
Manager	26	4.0	.3519	.0699	3.4	4.8
Supervisor	53	4.0	.4014	.0551	2.4	4.9
Employee	551	3.7	.4031	.0172	1.5	5.0
Non-Exempt	41	3.8	.4622	.0722	2.8	4.9
Total	671	3.8	.4171	.0161	1.5	5.0

The MANOVA F value was $F_{(9,1618.57)} = 5.33$, p=.001, indicating that significant differences exist between job position and individual safety scores. Post hoc analysis was performed based on significant differences found using Tukey's HSD. Job positions *Employee*, *Non-exempt* and *Manager* scored significantly lower for safety factor "Risk Taking Behaviors" than job positions *Supervisor*. Safety factor "Risk Taking Behaviors" is presented in Table 4.12 Job Position and Safety Factor "Risk Taking Behaviors" Mean Scores from the Hall Safety Climate Instrument Field Study.

Job positions *Employee* and *Non-exempt* scored significantly lower for safety factor "Manager/Supervisor Support" than job positions *Manager* and *Supervisor*. Safety factor "Manager/Supervisor Support" is presented in Table 4.13 Job Position and Safety Factor "Manager/Supervisor Support" Mean Scores from the Hall Safety Climate Instrument Field Study.

Safety Climate and Safety Factor Mean Scores by Department

ANOVA analyses were conducted to determine if there was a significant difference in self-reported department and overall safety climate. Self-reported department was the independent variable and was compared to the average overall score of the instrument. Department categories included: (1) Melt Shop; (2) Rolling Mill; (3) Maintenance; (4) Administration; and (5) Contractor

ANOVA analysis detected no significant differences at a p=.05 level in responses to job position and overall safety climate. The ANOVA F value was $F_{(4,666)}=2.23$,p=.064, indicating no significant differences between department and overall safety factor score.

Table 4.12 Job Position and Safety Factor “Risk Taking Behaviors” Mean Scores from the Hall Safety Climate Instrument Field Study

Self-Reported Job Position	Number of Respondents	“Risk Taking Behaviors” Mean Score
Manager	26	3.7
Supervisor	53	3.8
Employee	551	3.4
Non-exempt	41	3.6

Table 4.13 Job Position and Safety Factor “Manager/Supervisor Support” Mean Scores from the Hall Safety Climate Instrument Field Study

Self-Reported Job Position	Number of Respondents	“Manager/Supervisor Support” Factor Mean Score
Manager	26	4.0
Supervisor	53	4.1
Employee	551	3.7
Non-exempt	41	3.9

Results indicate that safety climate is not different between employees based on department. Safety climate score is presented in Table 4.14 Department Safety Climate Mean Score from the Hall Safety Climate Instrument Field Study.

MANOVA analyses were conducted to determine if significant differences existed between self-reported department and individual safety factor scores. Self-reported department was the independent variable and was compared to individual safety factor scores.

MANOVA analysis detected significant differences at a p=.05 level in department and individual safety factor scores. The MANOVA F value was $F_{(12,\ 1757.07)} = 2.26$, p=.008, indicating that significant differences exist between department and individual safety factor scores. Post hoc analysis was performed based on significant differences found using Tukey's HSD. Departments *Rolling Mill*, *Contractors*, *Melt Shop* and *Administration* scored significantly lower for safety factor "Manager/Supervisor Support" than *Maintenance*. Safety factor "Manager/Supervisor Support" mean scores are presented in Table 4.15 Department and Safety Factor "Manager/Supervisor Support" Mean Scores from the Hall Safety Climate Instrument Field Study.

Safety Climate and Safety Factor Mean Scores by Previous Work-Related Injury Experience

ANOVA analyses were conducted to determine if there was a significant difference in self-reported prior work-related injury experience and overall safety climate. Self-reported prior work-related injury experience was the independent variable and was compared to the average overall score of the instrument.

Table 4.14 Department Safety Climate Score Mean from the Hall Safety Climate Instrument Field Study

Self-Reported Department	Number of Respondents	Mean	Std. Dev.	Std. Error	Min.	Max.
Rolling Mill	227	3.7	.3854	.0256	2.6	4.9
Melt Shop	183	3.7	.4345	.0321	2.5	5.0
Maintenance	116	3.8	.4640	.0431	1.5	5.0
Administration	90	3.8	.3887	.0410	2.6	4.9
Contractor	55	3.8	.4054	.0547	2.8	4.9
Total	671	3.8	.4171	.0161	1.5	5.0

Table 4.15 Department and Safety Factor “Manager/Supervisor Support” Mean Scores from the Hall Safety Climate Instrument Field Study

Self-Reported Department	Number of Respondents	“Manager/Supervisor Support” Mean Score
Rolling Mill	227	3.7
Melt Shop	183	3.7
Maintenance	116	3.9
Administration	90	3.8
Contractor	55	3.7
Total	671	

Responses to the item “At this or any previous place of employment have you ever been involved in a work-related accident that resulted in an injury?” were (1) yes and (0) no.

ANOVA analysis detected a significant difference at a p=.05 level in responses to self-reported prior work-related injury experience and overall safety climate. The ANOVA F value was $F_{(1,669)}$=4.85, p=.028, indicating a significant difference between self-reported prior work-related injury experience and overall safety climate. Respondents that reported a prior work-related injury experience scored significantly lower than those that reported no prior work-related injury. Safety climate mean scores for injury experience is presented in Table 4.16 Prior Work-Related Injury Experience Safety Climate Mean Scores from the Hall Safety Climate Instrument Field Study.

MANOVA analyses were conducted to determine if significant differences existed between self-reported prior work-related injury experience and individual safety factor scores. Self-reported prior work-related injury experience was the independent variable and was compared to individual safety factor scores.

MANOVA analysis detected significant differences at a p=.05 level in self-reported prior work-related injury experience and individual safety factor scores. The MANOVA F value was $F_{(3,667)}$ = 5.20, p=.001, indicating that significant differences exist between self-reported prior work-related injury experience and individual safety scores.

Table 4.16 Prior Work-Related Injury Experience Safety Climate Mean Scores from the Hall Safety Climate Instrument Field Study

Self-Reported Injury Experience	Number of Respondents	Mean Score	Std. Deviation	Std. Error	Min.	Max.
“NO”	107	3.8	.4542	.0439	2.4	4.9
“YES”	564	3.7	.4083	.0172	1.5	5.0
Total	671	3.8	.4171	.0161	1.5	5.0

Individuals that responded (1) ”yes” to prior work-related injury experience scored significantly lower for safety factor “Risk Taking Behaviors” than those that responded (2) “no”. Safety factor mean score for injury experience is presented in Table 4.17 Prior Work-Related Injury Experience and Safety Factor “Risk Taking Behaviors” Mean Scores from the Hall Safety Climate Instrument Field Study.

Safety Climate and Safety Factor Mean Scores by Awareness of Hazard in Immediate Work Area

ANOVA analyses were conducted to determine if there was a significant difference in self-reported awareness of hazard in immediate work area and overall safety climate. Self-reported awareness of hazard in immediate work area was the independent variable and was compared to the average overall score of the instrument. Responses to the item “Are there any hazards in your direct work area?” were (1) yes and (0) no.

The results of the ANOVA analysis found no significant differences at a p=.05 level in responses to awareness of hazard in immediate work area and overall safety climate. The ANOVA F value was $F_{(1,669)}=3.19, p=.075$, indicating no significant differences between awareness of hazard in immediate work area and overall safety factor score. Results indicate that safety climate is not different between employees based on awareness of hazard in immediate work area. Safety climate mean scores for hazard awareness are presented in Table 4.18 Awareness of Hazard in Immediate Work Area Safety Climate Mean Scores from the Hall Safety Climate Instrument Field Study.

Table 4.17 Prior Work-Related Injury Experience and Safety Factor “Risk Taking Behaviors” Mean Scores from the Hall Safety Climate Instrument Field Study

Self-Reported Injury Experience	Number of Respondents	Mean Score
“NO”	107	3.6
“YES”	564	3.4

Table 4.18 Awareness of Hazard in Immediate Work Area Safety Climate Mean Scores from the Hall Safety Climate Instrument Field Study

Self-Reported Hazard Awareness	Number of Respondents	Mean Score	Std. Deviation	Std. Error	Min.	Max.
“NO”	227	3.8	.4367	.0290	2.4	4.9
“YES”	444	3.7	.4057	.0193	1.5	5.0
Total	671	3.8	.4171	.0161	1.5	5.0

MANOVA analyses were conducted to determine if significant differences existed between self-reported awareness of hazard in immediate work area and individual safety factor scores. Self-reported awareness of hazard in immediate work area was the independent variable and was compared to individual safety factor scores.

MANOVA analysis detected significant differences at a p=.05 level in self-reported awareness of hazard in immediate work area and individual safety factor scores. The MANOVA F value was $F_{(3,667)} = 2.96$, p=.032, indicating that significant differences exist between self-reported awareness of hazard in immediate work and individual safety scores. Individuals that responded (1) ”yes” to awareness of hazard in immediate work area scored significantly lower for safety factor “Risk Taking Behaviors” than those that responded (2) “no”. Safety factor mean scores for hazard awareness are presented in Table 4.19 Awareness of Hazard in Immediate Work Area and Safety Factor “Risk Taking Behaviors” Mean Scores from the Hall Safety Climate Instrument Field Study.

Safety Climate and Safety Factor Mean Scores by Geographic Work Location

ANOVA analyses were conducted to determine if there were significant differences in geographic work location and overall safety climate. Geographic work location was the independent variable and was compared to the average overall score of the instrument. Geographic work locations were: (1), (2) and (3).

ANOVA analysis detected significant differences at a p=.05 level in geographic work location and overall safety climate.

Table 4.19 Awareness of Hazard in Immediate Work Area and Safety Factor “Risk Taking Behaviors” Mean Scores from the Hall Safety Climate Instrument Field Study

Self-Reported Hazard Awareness	Number of Respondents	Mean Score
“NO”	227	3.5
“YES”	444	3.4

The ANOVA F value was $F_{(2,668)}$=38.45, p=.001, indicating significant differences between geographic work location and overall safety climate. Post hoc analysis was performed based on the significant differences found using Tukey's HSD. Locations No.3 and No.2 scored significantly lower than location No.1. Safety climate mean scores by location are presented in Table 4.20 Geographic Work Location and Safety Climate Mean Scores from the Hall Safety Climate Instrument Field Study.

MANOVA analyses were conducted to determine if significant differences existed between geographic work location and individual safety factor scores. Geographic work location was the independent variable and was compared to individual safety factor scores.

MANOVA analysis detected significant differences at a p=.05 level in location and individual safety factor scores. The MANOVA F value was $F_{(6,1332.00)}$ = 22.58, p=.000, indicating that significant differences exist between location and individual safety scores. Post hoc analysis was performed based on significant differences found using Tukey's HSD. Locations No.2 and No.3 scored significantly lower for safety factor "Risk Taking Behaviors" than location No.1. Safety factor "Risk Taking Behaviors" mean scores by location are presented in Table 4.21 Geographic Work Location and Safety Factor "Risk Taking Behaviors" Mean Scores from the Hall Safety Climate Instrument Field Study.

Table 4.20 Geographic Work Location and Safety Climate Instrument Mean Scores from the Hall Safety Climate Field Study

Survey Location	Number of Respondents	Safety Climate Mean Score	Std. Deviation	Std. Error	Min.	Max.
No.1	280	3.9	.3921	.0234	2.4	5.0
No.2	196	3.7	.3579	.0256	2.6	4.6
No.3	195	3.6	.4346	.0311	1.5	4.6
Total	671	3.8	.4171	.0161	1.5	5.0

Table 4.21 Geographic Work Location and Safety Factor “Risk Taking Behaviors” Mean Scores from the Hall Safety Climate Instrument Field Study

Survey Location	Number of Respondents	“Risk Taking Behaviors” Mean Score
No.1	280	3.6
No.2	196	3.4
No.3	195	3.3

Locations No.2 and No.3 scored significantly lower for safety factor "Manager/Supervisor Support" than location No.1. Safety factor "Manager/Supervisor Support" mean scores by location are presented in Table 4.22 Geographic Work Location and Safety Factor "Manager/Supervisor Support" Mean Scores from the Hall Safety Climate Instrument Field Study.

Locations No.2 and No.3 scored significantly lower for safety factor "Safety System Program" than location No.1. Safety factor "Safety System Program" mean scores are presented in Table 4.23 Geographic Work Location and Safety Factor "Safety System Program" Mean Scores from the Hall Safety Climate Instrument Field Study.

Summary

This chapter presented the analysis and interpretation of data collected during the development and field test of the Hall Safety Climate Instrument. Pathway model testing resulted in an acceptable fit for the instrument. Factor analysis revealed an initial five factor solution for the pilot data. Confirmatory factor analysis and follow up exploratory factor analysis resulted in a three-factor solution for the field testing data. Significant differences were found during the ANOVA and MANOVA testing of the Likert-type item responses and specific differences identified with Tukey's HSD, and will be discussed in Chapter V.

Table 4.22 Geographic Work Location and Safety Factor “Manager/Supervisor Support” Mean Scores from the Hall Safety Climate Instrument Field Study

Survey Location	Number of Respondents	“Manager/Supervisor Support” Mean Score
No.1	280	4.0
No.2	196	3.5
No.3	195	3.6

Table 4.23 Geographic Work Location and Safety Factor “Safety System Program” Mean Scores from the Hall Safety Climate Instrument Field Study

Location	Frequency	“Safety System Program” Mean Scores
No.1	280	4.1
No.2	196	4.0
No.3	195	3.9

CHAPTER V

FINDINGS, CONCLUSIONS, RECOMMENDATIONS, AND SUMMARY

Introduction

The purpose of this chapter was to summarize the findings, conclusions, and recommendations resulting from the self-reported safety climate survey responses to assess the safety climate of a steel mini-mill employer in the United States. The data analyzed in this research study were from employees of a steel mini-mill employer located in the United States. This analysis was conducted using descriptive statistics, factor analysis, pathway analysis, ANOVA, and MANOVA. When statistical results indicated further analysis Post Hoc measures using Tukey's HSD were performed.

The purpose of this study was to assess the safety culture, using a theory based safety climate instrument that was valid and reliable, of employees in a high-risk industrial setting. Further study of group differences was conducted using the valid and reliable safety climate instrument. Respondents numbering 671 out of a possible 955 (70.3%) voluntarily and anonymously completed the safety climate surveys. The Hall Safety Climate Instrument was comprised of a 34 response items, four independent variable items. The response data was entered into Excel and later exported into Statistical Package for Social Sciences (SPSS 14.0) for analysis.

Descriptive and inferential statistic analyses were performed. Factor analyses along with Cronbach's alpha were used to establish reliability. A panel of experts was selected to assess the face validity of the safety themes to theory construct assignment and item structure. Further validity was established using pathway analysis techniques that include measuring the model fit and structural equation modeling. Group differences in safety climate and mean safety factor scores were identified through analysis of variance (ANOVA) and multiple analysis of variance (MANOVA). Specific differences in safety climate among groups were characterized by post hoc analysis with Tukey's HSD.

Findings

Validity and reliability testing of the Hall Safety Climate Instrument

The "Hall Safety Climate Instrument" was created and validated, to assess the safety climate of workers in high risk occupations in heavy industry such as workers employed at three steel mini-mill locations in the United States. Steps involved in the development of the Hall Safety Climate instrument first required the creation of The Hall model based on the theory of planned behavior. This was accomplished by linking safety themes selected from current safety management research to the theory of planned behavior constructs. Then an expert panel was assembled and requested to validate that each safety management related theme was correctly assigned to the appropriate theory construct. Specific survey items representing each theme were determined by the research through a rigorous search of the literature and review of other psychometric instruments. The expert panel was also requested to review the assignment of each survey items previously assigned to an appropriate theme by the researcher. The researcher then established internal consistency reliability and factor analysis reliability through the pilot testing of the survey instrument with employees at a steel mini-mill location in the United States and the analysis of the data the pilot study provided   Further reliability was measured by conducting a pathway analysis of the Hall model using AMOS 6.0 to refine the model and achieving excellent model fit statistics.

1. This research study found that the Hall Safety Climate instrument reliable and was considered by the expert panel to accurately reflect intended themes. Validity was established by the structural equation modeling procedures described in Chapter III Methodology within the Pathway Analysis section

Safety Climate Profile of Workers at Three Steel Mini-Mill Locations

2. A majority of employees and on-site contractors at steel mini-mills participating in the research field study indicated that safety climate was "high".

3. Responses to the safety climate factor for "Safety System Programs" for steel mini-mill employees and on-site contractors indicate a majority of study participants report company safety programs are effective.

4. Responses to the safety climate factor for "Manager/Supervisor Support" for steel mini-mill employees and on-site contractors indicate a majority of

participants report that managers and supervisors support safety at the organizational level.

5. Responses to the safety climate factor for "Risk Taking Behaviors" for steel mini-mill employees and on-site contractors indicate a majority of participants report an intention to avoid risk taking behaviors that circumvent company safety procedures.

6. A majority of employees and on-site contractors at steel mini-mills participating in the study self-reported agreement or strong agreement with the statement "I know other workers at the company that do not follow safety procedures".

7. When responses of all employees and on-site contractors participating in the study were analyzed by individual item, all the mean scores for individual items except the response related to the statement "I know other workers who do not follow safety procedures" resulted in a majority of responses agree with items reflecting a high safety climate.

Job Position: Safety Climate/Safety Factor

8. Participants at steel mini-mills located in the United States in Manager and Supervisor job positions self-reported higher company safety climate than Employee and Non-exempt job positions.

9. Participants at steel mini-mills located in the United States in Supervisor job position reported under the safety climate factor for “Risk Taking Behaviors”, an intention to avoid risk taking behaviors that circumvent company safety procedures higher than the safety climate factor reported by Managers, Employees, and those respondents in Non-exempt job positions.

Department Affiliation: Safety Climate/Safety Factor

10. Participants at steel mini-mills located in the United States self-reported no difference in total safety climate regardless of the department location of the respondent. All reported a high company safety climate.

11. Participants at steel mini-mills located in the United States working in Maintenance departments reported a significantly higher safety climate factor for “Manager/Supervisor Support”, for safety at the organizational level than the other departments including the departments of Rolling Mill, Contractor, Melt Shop, and Administration using a .05 level of significance.

Work-Related Injury Experience: Safety Climate/Safety Factor

12. Participants at steel mini-mills located in the United States that had no previous work-related injury experience reported significantly higher

company safety climate than those who have had a previous work-related injury experience using a .05 level of significance.

13. Participants at steel mini-mills located in the United States that had no previous work-related injury experience reported a significantly higher safety climate factor for "Risk Taking Behaviors", the intention to avoid risk taking behaviors that circumvent company safety procedures than those who have had a previous work-related injury experience, using a .05 level of significance.

Hazard Awareness: Safety Climate/Safety Factor

14. Participants at steel mini-mills located in the United States that indicated that they were aware of hazards in their immediate work area self-reported company safety climate that was not significantly different than those that self-reported no awareness of hazards in their immediate work area, using a .05 level of significance. Rewrite no difference p value .05

15. Participants at steel mini-mills located in the United States that indicated that they were not aware of hazards in their immediate work area reported a significantly higher safety climate factor for "Risk Taking Behaviors", the intention to avoid risk taking behaviors that circumvent company safety procedures than those that self-reported an awareness of hazards in their immediate work area, using a .05 significance level.

Facility Location: Safety Climate/Safety Factor

16. Participants at steel mini-mills in the United States at location No.1 self-reported significantly higher company safety climate than location No.2 and location No.3 using a .05 significance level.

17. Participants at steel mini-mills in the United States at location No. 1 reported a significantly higher safety climate factor for “Safety System Program”, that company safety programs are effective than location No.2 and location No.3., using a .05 significance level.

18. Participants at steel mini-mills in the United States at location No.1 reported a significantly higher safety climate factor for “Manager/Supervisor Support” for safety at the organizational level than location No.2 and location No.3.

19. Participants at steel mini-mills in the United States at location No.1 reported significantly higher safety climate factor for “Risk Taking Behaviors”, an invention to avoid risk taking behaviors that circumvent company safety procedures than location No.2 and location No.3.

Conclusions

1. The newly developed safety climate instrument titled the “Hall Safety Climate Instrument” was reliable and validated by structural equation modeling. The Hall Safety Climate Instrument met the requirements of validity and reliability as prescribed in the study.

2. A high safety climate was reported by employees and on-site contractors participating in the study at the three mini-mills located in the United States using the Hall Safety Climate Instrument. High safety climates in high risk occupational environments have been found in previous studies (Brown et al., 2000; Dedobbeleer & Beland, 1991; Fogarty & Shaw, 2004).

3. A higher safety climate among employees and on-site contractors participating in the study at the three mini-mills located in the United States was reported using the Hall Safety Climate Instrument for Manager and Supervisor job positions group than the Employee and Non-exempt job positions group. The existence of separate safety climates among workers is supported by studies of group differences in safety climate (Fogarty & Shaw, 2004; Hayes et al., 1998; Williamson et al., 1997).

4. The Maintenance department reported a higher safety climate factor than the other departments for “Manger/Supervisor Support” for safety at the organizational

level among employees and on-site contractors participating in the study at the three mini-mills located in the United States using the Hall Safety Climate Instrument. The existence of separate safety climates among workers is supported by studies of group differences in safety climate (Fogarty & Shaw, 2004; Hayes et al., 1998; Williamson et al., 1997).

5. A higher safety climate among employees and on-site contractors participating in the study at the three mini-mills located in the United States was reported using the Hall Safety Climate Instrument for those that self-reported previous no work-related injury experience than those that reported a previous work-related injury experience. Williamson et al. (1997) found differences in safety climate among groups that reported previous injuries and those that reported no previous injury.

6. A higher safety climate factor for “Risk Taking Behaviors”, an intention to avoid risk behaviors that circumvent company safety procedures, among employees and on-site contractors participating in the study at the three mini-mills located in the United States was reported using the Hall Safety Climate Instrument for those that reported no awareness of hazards in their immediate work area than those that reported an awareness of hazards in their work area. Williamson et al. (1997) found differences in safety climate among workers that a hazard awareness and those that reported no hazard awareness.

7. Employees and on-site contractors of steel mini-mills at different geographic work locations may not share the same safety climate. The difference in safety climate among geographic locations is supported by a study that found differences in safety climate at two locations of a corporately owned nuclear waste D&D service provider (Smith-Crowe, Burke, & Landis, 2003).

Recommendations

1. The newly developed safety climate instrument titled the "Hall Safety Climate Instrument" can be used in follow up studies at the three steel mini-mill locations to measure differences in safety climate and safety factor scores over time.
   The Hall Safety Climate Instrument can be applied to industries with similar organizational structure and work environments as steel mini-mills in the United States. Similar organizational structures are those with clearly defined management, supervisor, and employee job positions. The Hall Safety Climate Instrument was designed to be used in a high safety reliability work environment as the steel mini-mills under study.

2. When the company is assessing its safety climate it should not solely rely on the self-report of managers and supervisors companies should systematically incorporate methods to have an ongoing program of safety climate assessment with high participation from employees who are hourly, non-exempt or on-site contractors to achieve an accurate assessment of safety climate at a facility

3. When the company is assessing its safety climate it could systematically incorporate methods to have an ongoing program of safety climate assessment of departments to achieve an accurate assessment of safety climate at a facility.

4. Workers with a previous injury report higher risk taking behavior. Future safety program considerations should have a special initiative to assist injured workers gain a stronger positive behavior about reducing risk taking behavior.

5. The awareness of hazards in the immediate work area has a degrading effect on safety climate, any hazards need to be reported and corrected.

6. Differences in safety climate among employees and on-site contractors in three steel mini-mills located in the United States which use the same corporate safety management system require further research to explore factors beyond the safety programs and procedures that may influence safety climate.

Summary

This chapter presented the analysis and interpretation of data collected from workers of a steel mini-mill with locations in the United States using the Hall Safety Climate Instrument. The Hall Safety Climate Instrument was shown to be reliable through the use of factor analysis and validated by structural equation modeling. The field testing of the final instrument revealed group differences in safety climate and individual safety factor scores. A baseline has been set for the participating steel mini-mill locations and it is recommended that follow studies be conducted to track changes over time.

CHAPTER VI

THE STUDY IN RETROSPECT

The use of the Hall Safety Climate Instrument detected influences of safety climate. These factors could be used to target resources to improve the safety climate within a given organization. Injuries resulting in days away from work, restricted work activity, or job transfer incidence rates are lagging measures used by safety managers to assess the performance of the safety management system. After an injury occurs the only way to improve the number is to manipulate the reporting criteria. An example would be if an electrician failed to properly lock out a piece of equipment before performing work and received a serious shock that caused an injury resulting in days away from work. The safety manager could rationalize that the minute the electrician failed to follow safety procedures he was considered suspended. The injury was recorded at a lower level than one requiring days away from work because now the electrician is considered suspended; therefore, he will not miss days of work due to the injury. The end result is that a serious injury occurred but will be represented as a lost time accident. Thus, when this data is reviewed to assess safety performance a false accounting of events is presented.

A better measure of safety program performance would be to observe the organization’s safety climate. Safety climate is a collection of perceptions about safety from all participating employees of the organization. The use of the Hall Safety Climate

Instrument allows all employees to record personal perceptions of safety and provides a measure of the perceptions. In the lagging measure described above, only affected employees are involved in the safety program assessment. In a safety climate study, all employees are asked to participate which gives the assessment greater depth into underlying factors that influence the organization's safety culture.

The initial assessment provided by the Hall Safety Climate Instrument allows the participating steel mini-mills to measure their safety climate using a valid and reliable instrument. The baseline information gathered by the Hall Safety Climate Instrument may be used as a starting point to measure effectiveness of improvements made to the safety program and policies. The homogeneous profile of the steel mini-mill locations facilitated measurement of group differences that may not have been possible using smaller sample sizes. Company-wide safety policies helped to control biases that may have influenced group differences. Volunteer participation was excellent and provided a large sample population that increased the reliability of the data analysis.

The geographical locations prevented the researcher from being present during the introduction and administration of the survey instrument. However, meaningful communication with the safety management personnel resulted in an effective delivery and collection of the surveys. The surveys were hand entered into Excel, which proved to be a tedious exercise. Future implementation of the survey instrument will be conducted using a scanable format which would improve results analysis. Safety climate instruments are limited to measuring climate at a particular point in time. This necessitates follow-up studies to develop a better grasp of the overall safety culture at select facilities. A safety manager has to be mindful of the different group perceptions of the safety climate which may require a safety program designed to address the differences.

Additional methodologies could be developed to enhance the study. At this particular corporation the “Employee” job classification was where a majority of the participants responded. The methodology for consolidation of smaller groups should be addressed. Incomplete surveys were those with any missing data point. The numbers of surveys considered incomplete in this study were few. However, this may not be the case at other locations; the methodology to “handle” missing data should be developed to retain the responses to items reported. The results of the study should be a benefit to all involved. Safety managers may want the results presented in a way that easy to give back to the participants. To address this, the coversheet which collects independent variables for the study should receive input from the facility safety managers. Methods should be taken to include the variables useful to the safety managers but able to be collapsed into study measures.

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APPENDICES

Appendix A: IRB

The IRB Form A was assigned the number 791A by the University Of Tennessee Office Of Research. The original copies of the Form A and Form D are on file in the Department of Instruction Technology, Health, and Cultural Studies at the University of Tennessee, Knoxville.

Appendix B. Hall Safety Climate Instrument Instruction Sheet

Introduction: Gerdau Ameristeel is conducting a safety climate survey at three steel mini mill locations in the United States. In addition, the data will be used by the University of Tennessee to study the safety climate at steel mini mills in the United States. Gerdau Ameristeel will review a summary of survey results help determine ways of improving the safety and health program at Ameristeel. The UT Safety Center at the University of Tennessee and the graduate student working on this project will use the information to meeting degree requirements and to expand the body of knowledge about safety climate within the steel mini-mill industry and assess the use of a new safety climate instrument. You are invited to voluntarily participate in the study. If you choose to participate in this study your responses will be anonymous and confidential. Your participation is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at anytime without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed your data will be returned to you or destroyed. Return of the completed survey constitutes your consent to participate.

Instructions for completing the survey:

- The survey items are a series of statements. Indicate the extent to which you agree or disagree with each by circling your response.
- The last page contains items that permit placing your responses into various groups. Indicate your answer by circling you response.
- If you do not understand the question please leave it blank.
- Once you have completed the survey, place the survey form into box as instructed by your Safety Manager. Your responses are confidential and should not be shared with others.

Your involvement in the study:

Your participation in the study will benefit you, your employer and the steel mini-mill industry by identifying important safety concerns, attitudes and beliefs important to your safety, the safety of co-workers and the safety of others who are employed in the steel mini-mill industry. All survey responses are anonymous to ensure your privacy.

If you have questions about your rights as a participant in the University of Tennessee study, contact The University of Tennessee Office of Research Compliance Services at (865)974-3466.

Thank you for your participation in this research study. You may request a summary of the key results found at the completion of the study by sending an email to utsafety@utk.edu.

Appendix C. Instructions for Hall Safety Climate Instrument Administrator

Survey Administration Instruction Sheet

Announce the survey and read aloud the Introduction Sheet which accompanies each survey packet.

Announce that it should take approximately 15 to 20 minutes to complete the survey.

Identify the location of the collection box and instruct the participants to place all surveys, whether they are completed or not, into the collection box.

Place the collection box in an area that you cannot directly observe the individuals as they place surveys in the box.

Designate an individual in each group to come notify you when everyone has placed their survey in the collection box.

Secure the collection box with shipping tape and affix a shipping label to the box.

Mail the box to:

Appendix D. Hall Safety Climate Instrument Cover Sheet

All responses will be strictly anonymous so please take the time to answer all survey items to the best of your ability. Indicate the degree to which you agree or disagree by circling the appropriate answer. Additional information will be collected and will be used to refine the current survey (See below).

*Note
QA Employees select Melt Shop Ops or Rolling Mill Ops
Rail Yard Employees select Melt Shop Ops

Mark the appropriate answer by checking the appropriate box.

1. Department

- ☐ Melt Shop Ops
- ☐ Rolling Mill Ops
- ☐ Maintenance
- ☐ Contractor
- ☐ Administration

2. Level

- ☐ Manager
- ☐ Supervisor
- ☐ Employee
- ☐ Non Exempt

Circle the appropriate answer

3. Are there any hazards in your direct work area?

Yes or No

4. At this or any previous place of employment have you ever been involved in a work-related accident that resulted in an injury?

Yes or No

Appendix E. Pilot Hall Safety Climate Instrument

1. My training enables me to recognize safety hazards at my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2. Increased work safety procedures would make my job safer	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3. Sometimes I am unsure how to do my job safely	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
4. I know how to report work-related injuries	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5. I know how to report work safety hazards	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
6. I feel that my productivity is more important than my safety	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
7. I would report other workers who were not following safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
8. I know other workers at my company that do not follow work safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
9. Supervisors devote sufficient effort to work safety	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
10. Management cares if I follow safety procedures required by my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
11. I will skip work safety procedures if I know other workers at my company are not watching	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
12. Supervisors listen to my ideas on how to improve work safety	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13. I know workers at my company that do not care whether fellow workers are following safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
14. Incentive programs make me want to follow safety procedures required by my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
15. I pay attention to safety while doing my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
16. I know workers at my company that can do their job without following work safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
17. Management feels that work safety is a high priority	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
18. My safety equipment protects me from injury even if I do not follow work safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
19. Management cares if I follow work safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
20. I am aware of departments at my company that do not care if work safety procedures are followed	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
21. My work safety equipment is always in working order	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

22. If I don't know all the work safety hazards for a job, I will still do the job because that's what I'm being paid to do	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
23. I can work in unsafe conditions and not suffer an injury	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
24. Before starting a task I make sure that I know all the work safety procedures that are required for that task	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
25. I understand the safety risks associated with my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
26. My job includes adequate safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
27. If I see equipment that is not in safe working order, I can have that equipment taken out of service	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
28. I am informed of new work safety procedures that will affect me	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
29. Safety procedures make my job safer	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
30. I am sure in my ability to work safely	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
31. Supervisors talk to me about work safety	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
32. I would report a work safety hazard if I was aware of one	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
33. I use required safety equipment while doing my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
34. I will do whatever it takes to get the job done, even if it means ignoring work safety rules	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
35. Sometimes I am expected to do more work than I can safely do	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
36. I am required to regularly attend work safety meetings	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
37. Management discourages employees from not following work safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
38. I can get safety equipment that is required for my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
39. Someone checks to see I use safety equipment if it is required by my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
40. Supervisors expect me to follow work safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
41. Supervisors are helpful if asked about work safety	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
42. I check my work safety equipment regularly to see if it is working properly	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
43. Management takes my personal safety seriously	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

44. I am clear about my responsibilities for job safety	Strongly Disagree Disagree Neutral Agree Strongly Agree
45. I know workers at my company that look out for each other	Strongly Disagree Disagree Neutral Agree Strongly Agree
46. Sometimes I will skip work safety procedures to get my job done	Strongly Disagree Disagree Neutral Agree Strongly Agree
47. Safety procedures required by my job are not necessary to protect me from injury	Strongly Disagree Disagree Neutral Agree Strongly Agree
48. Supervisors check to see if I am following safety procedures required by my job	Strongly Disagree Disagree Neutral Agree Strongly Agree
49. If I have an idea to improve work safety, it will be considered by the company	Strongly Disagree Disagree Neutral Agree Strongly Agree
50. Safety meetings give me information that helps me to work safely	Strongly Disagree Disagree Neutral Agree Strongly Agree
51. If I do not follow work safety procedures for my job, I will suffer an injury	Strongly Disagree Disagree Neutral Agree Strongly Agree
52. If I violate safety procedures required by my job I will be disciplined	Strongly Disagree Disagree Neutral Agree Strongly Agree
53. Supervisors regularly discuss work safety goals with me	Strongly Disagree Disagree Neutral Agree Strongly Agree
54. I would follow work safety procedures regardless if I thought it was necessary or not	Strongly Disagree Disagree Neutral Agree Strongly Agree
55. If I thought an area was unsafe I would check to see what additional safety measures were needed before I entered	Strongly Disagree Disagree Neutral Agree Strongly Agree
56. Supervisors will know if I do not follow safety procedures required by my job	Strongly Disagree Disagree Neutral Agree Strongly Agree
57. The training I have received for my job has prepared me to work safely	Strongly Disagree Disagree Neutral Agree Strongly Agree
58. If I reported a work safety hazard, someone would correct it	Strongly Disagree Disagree Neutral Agree Strongly Agree
59. I understand safety procedures required by my job	Strongly Disagree Disagree Neutral Agree Strongly Agree
60. I can do my job without following required safety procedures	Strongly Disagree Disagree Neutral Agree Strongly Agree
61. My work equipment is regularly maintained to reduce my exposure to safety hazards	Strongly Disagree Disagree Neutral Agree Strongly Agree
62. Management would respond quickly to my work safety concerns	Strongly Disagree Disagree Neutral Agree Strongly Agree
63. Managers only think about work safety if there has been an injury	Strongly Disagree Disagree Neutral Agree Strongly Agree
64. I would report any injury I suffered on the job	Strongly Disagree Disagree Neutral Agree Strongly Agree
65. My job performance will be slower if I follow work safety procedures	Strongly Disagree Disagree Neutral Agree Strongly Agree

Appendix F. Hall Safety Climate Instrument

5.	My work safety equipment is always in working order	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
6.	Supervisors regularly discuss work safety goals with me	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
7.	I am required to regularly attend work safety meetings	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
8.	I know workers at my company that look out for each other	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
9.	Safety procedures make my job safer	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
10.	Management takes my personal safety seriously	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
11.	The training I have received for my job has prepared me to work safely	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
12.	If I reported a work safety hazard, someone would correct it	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13.	I check my work safety equipment regularly to see if it is working properly	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
14.	I use required safety equipment while doing my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
15.	Safety meetings give me information that helps me to work safely	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
16.	Sometimes I will skip work safety procedures to get my job done	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
17.	My job performance will be slower if I follow work safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
18.	I understand the safety risks associated with my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
19.	I know how to report work-related injuries	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
20.	Supervisors listen to my ideas on how to improve work safety	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
21.	I know workers at my company that can do their job without following work safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
22.	I am aware of departments at my company that do not care if work safety procedures are followed	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
23.	Before starting a task I make sure that I know all the work safety procedures that are required for that task	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
24.	I can get safety equipment that is required for my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

25.	If I have an idea to improve work safety, it will be considered by the company	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
26.	Sometimes I am unsure how to do my job safely	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
27.	I can work in unsafe conditions and not suffer an injury	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
28.	Management would respond quickly to my work safety concerns	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
29.	If I don't know all the work safety hazards for a job, I will still do the job because that's what I'm being paid to do	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
30.	Supervisors devote sufficient effort to work safety	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
31.	Safety procedures required by my job are not necessary to protect me from injury	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
32.	I understand safety procedures required by my job	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
33.	If I thought an area was unsafe I would check to see what additional safety measures were needed before I entered	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
34.	Sometimes I am expected to do more work than I can safely do	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
35.	I am clear about my responsibilities for job safety	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
36.	I know other workers at my company that do not follow work safety procedures	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
37.	I would report a work safety hazard if I was aware of one	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
38.	I will do whatever it takes to get the job done, even if it means ignoring work safety rules	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

VITA

Michael Edward Hall, the son of William Edward and Kwang-Suk Hall was born in Delaware on May 25, 1970. He graduated from Laurel Senior High School in 1988. After high school graduation Michael attended the University of Delaware, and Delaware Technical and Community College before graduating from Salisbury University in 1994 with a Bachelor of Science in Environmental Health Science. Michael earned a Masters of Science in Environmental Health Science in 1996 from East Tennessee State University.

After graduation Michael worked for the State of Florida Department of Health as an Environmental Specialist. Michael later worked for the State of Florida Department of Environmental Protection as an Environmental Specialist II.

In the fall of 2002, he enrolled at the University of Tennessee to pursue a PhD in Human Ecology, with a concentration in Community Health and a specialization in safety. His cognate area is in Human Resource Management. While attending the University of Tennessee Michael was a graduate teaching associate in the Department of Health and Safety.

In the summer of 2006 Michael accepted a position as Professor of Health Promotion at Mississippi State University in the Department of Food Science, Nutrition and Health Promotion.